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MUNGER AFRICANA LIBRARY NOTES

16

BLOOD GROUP GENE FREQUENCIES

An Indication of the Genetic Constitution of Population Samples in Cape Town

M. C. Botha
in association with Judith Pritchard

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by

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FRONT COVER: Courting scene in dark ochre. Height right-hand figure 6-1/2 inches. Manemba, Mtoko. Courtesy African Arts "Rock Painting of Southern Africa" by H. C. Woodhouse. Spring 1969.

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Introduction to the Political, Social, and Historical Background of the Study

The Coloured people of South Africa are a distinct cultural and racial group which has been in existence for over two centuries. It numbers over two million people. Moreover, it constitutes the largest community in South Africa's second city, Cape Town.

Physically and culturally, the Coloured people are distinct from the various African ethnic groups in South Africa. Although in the past they have drawn sharp political lines between themselves and the African groups, today there is a sense of a common "blackness" among some of the younger and politically more radical members of the Coloured community.

Because the "whites" outnumber the "Coloureds," there has never been the emotive fear by the "whites" of being "swamped" at the polls, as is usually expressed in regard to the large African majority. Historically, the Coloured community has, in the western Cape, participated closely, although often restricted by racial prejudice, in the general life of the society. There have been Coloured Provincial (U. S. State) Councillors, and Coloured property owners continue to vote for the Cape Town City Council, on which both Coloured men and women have served and Coloured representation continues.

While the numbers of Coloured voters never threatened to outvote the whites, they did constitute a potential bloc vote large enough to tip the balance between the two major white political parties. For some years the Coloured voters often favored Afrikaner candidates backed by General Hertzog. With the advent of Dr. Malan's purified National Party, the balance appeared to be swinging decisively to the predominately English-speaking United Party. To remove the Coloured voters of the Cape Province from the common parliamentary roll, the National Party engaged in what most of its leaders now look back upon as a devious method of bypassing the South African constitution. For a period the Coloured of the Cape were "compensated" by being allowed to vote for four white men to represent them. Then all representation for the Coloured people in the Central Parliament was abolished.

Since a majority of the Coloured population speaks Afrikaans at home and belongs to one of the Dutch Reformed Churches, and also due to historical background, the Afrikaners have long felt a special

relationship to the Coloured community. This was the traditional Afrikaner attitude. General Hertzog told Parliament in 1928, "It is our duty to put the Coloureds in South Africa on the same political basis on which we stand." Dr. Malan, himself, said that day, "To the Coloureds should be given the political rights of the White man."[1]

Of all groups in South Africa, the position of the Coloured people has been fixed time and again, only to become unfixed. The Oxford historian, W. M. MacMillan, in concluding a book on them referred to the constitution of 1853 as giving the Coloured people "security and potential equality." In 1927 he wrote, "The Coloured People have no political grievance, are proud of their rights, and, in spite of all disabilities, not only survive, but are definitely making upward progress. With every generation which passes, the new term 'Eur-African' becomes more and more an accurate description."[2]

To this day the Nederduits Gereformeerde Kerk does not by doctrine exclude Coloured people from its congregations. In the synod of 1857, when provision for Coloured churches was made, it was specifically indicated that this was not because of differences created by God, but rather because of the weakness of some whites. The outstanding Afrikaans theologian, Dr. B. B. Keet, in a seminal study a decade ahead of its time, pointed out that even in the "Mission Church" the Coloured minister "...is subject to all sorts of restrictions that are connected not with his lack of ability, but with his status as a non-white minister."[3] In Stellenbosch in 1956, Dr. Keet and I often discussed this matter, and he repeatedly returned to the theme that the Coloured people would provide the litmus paper by which Christianity would be tested in South Africa.

The Coloured people have always been aware of their legal and moral rights. Dr. A. Abdurahman, who is perhaps their greatest leader so far, was a member of the Provincial (State) Council. In his 1939 Presidential Address to this best organized and best sustained

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[1] Hansard, Vol. 10 Col. 1891 and Col. 1883.

[2] W. M. MacMillan, The Cape Colour Question. (London: Faber and Gwyer, 1927), p. 267 and p. 287.

[3] English translation of a book written to and for Afrikaners: Professor B. B. Keet, Whither South Africa. (Stellenbosch and Grahamstown: University Publishers, 1956), p. 38.

Coloured organization, he allied himself with the white oligarchy against the Axis powers by saying, "South Africa has a right to expect every man--white as well as Coloured--to do his duty."[1] Dr. Abdurahman went back to the Ordinance of 1828 which, as he put it, was the basis "for the broad political framework of 1852, within which White and Coloured were joined together by a bond of loyalty as free and equal citizens."[2] In tracing a decline in political rights (which were eventually to go down much farther than he could envision in his lifetime), Abdurahman viewed the Act of Union as a "huge betrayal" because the term "of European descent" deprived the Coloured people of political rights. This act, he declared, would "remain as a foul blot upon the political escutcheon of the Union."[3]

It is also worth noting, without going into great detail, that Coloured and white education was identical in content from the end of the 19th century until the Wilcocks Commission of Inquiry in 1937, which recognized the economically impoverished state of the Coloured community and subsequently recommended differential education. This occurred a few years after the Carnegie Commission had recognized the impoverished state of the Afrikaner community, with almost one in four Afrikaners listed as a "poor white." The best study of Coloured education has been published by the Institute of Race Relations.[4]

The Communist Party has not been particularly successful in penetrating the Coloured community, although for some years during the 1950s the Trotskyite movement among the Coloured people was among the two or three strongest Trotskyite movements in the world. In the heyday of the "Congress movement" there was a "Coloured People's Congress," but it was largely a front. Its leader, Piet Beyleveld, was an Afrikaner who later turned State

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[1] Presidential Address and Minutes of the General Conference of the African Peoples Organization (a wholly Coloured group, despite its name taken a generation before) held at Cape Town, April 11-14, 1939.

[2] Ibid.

[3] Ibid.

[4] The Education of the Coloured Community in South Africa 1652-1970, compiled by Muriel Horrell. (Johannesburg: Institute of Race Relations, 1970).

Witness against Communists in various Congress movements. It is interesting that the Coloured community is virtually ignored in a recent authorized history of the South African Communist Party.[1]

The history and politics of the Coloured people of South Africa are important because the Coloured population has so often been held in low esteem, not only by others but by itself as well. General Smuts, in his day a hero to many Coloured people, referred to "van der Kemp and Read, with their Hottentot wives and miserable progeny."[2] Whether the Coloured people will choose to merge with the whites or whether they will choose to consider themselves "black" and cast their lot with the African majority, today they constitute a distinct people with much to be proud of. If they can overcome their own poor image of themselves, as well as the often unfair image bestowed upon them by both whites and Africans, they could have a distinctive role in the future of South African race relations. As a "white" political leader once told me, "I am more South African than most of those who attack me, because I have English, Dutch, French, African, and Asian genes." I don't know if all these claims would be substantiated by a blood examination, but I'm sure English, Dutch, and some derivation of Coloured ancestry could be found.

The Tomlinson Commission, which was formed in order to plan the socio-economic development of Africans, concluded its labors as long ago as 1955. Dr. Verwoerd accepted its decisions as basic policy. The Commission made it emphatically clear in regard to Africans, and implicitly as far as the Coloured population was concerned, that "either the challenge must be accepted, or, the inevitable consequences of the Bantu and European population groups into a common society must be endured."[3]

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[1] A. Lerumo, Fifty Fighting Years: The South African Communist Party 1921-1971. (London: Inkululeko Publications, 1972).

[2] In his introduction to Sarah Gertrude MacMillan's King of the Bastards, (London: Heinemann, 1950). Mrs. MacMillan was a self-annointed expert on the Coloured people and condescendingly titled a widely read book about them as God's Stepchildren.

[3] Pretoria: Government Printer. Summary of the Report of the Commission for the Socio-Economic Development of the Bantu Areas within the Union of South Africa, 1955. p. 211.

At the present time a strong debate is going on in the Afrikaner community concerning the political future of the Coloured community. There is an equally strong debate being held in the Coloured community as to what position it should take. One view, which is largely that of the Afrikaner verligtes ("enlightened") element, stands for political integration of the Coloured population. Many of the opposing verkramptes ("cramped" or "narrow") have favored a "Colouredstan," a physical delimitation of a part of South Africa belonging to the Coloured people. This concept is not dissimilar to the desire expressed by the Black Muslims in the United States to preferring their own separate states or territory.

The cultural closeness of the "white" and "brown" Afrikaners makes this conflict very complex. In the 1960s Prime Minister Verwoerd "settled" the issue with his "granite wall" stance against "integration" of the Coloured people. A marked shift in attitude occurred in the 1970s when Prime Minister John Vorster found himself unable to quell discussion of the moral and ethical issues involved. The fact that he tried to shelve the issue by saying that it was a problem for the "next generation" was a significant change in Afrikaner political thinking.

On the Afrikaner side, such highly respected sociology scholars as Professor S. P. Cillier of Stellenbosch University and Dr. Hendrik van der Merwe of the Abe Bailey Institute of Inter-racial Studies at the University of Cape Town (both men having impeccable Afrikaans backgrounds), after very thorough study have declared themselves to be broadly in favor of better treatment now and, by implication, eventual integration of, the Coloured community.[1] Dr. van der Merwe concludes, "I am convinced that the middle road leads to complete political integration. With this opinion I am in very good company, and I believe the onus is upon those who disagree to disprove it. Until the opposite is proved, we have, obviously, no choice: by rejecting homelands we have chosen integration."[2]

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[1] S. P. Cillier, Appeal to Reason (Stellenbosch: University Publishers, 1971). Cillier makes a point of stating that, as an Afrikaner, he would have preferred to publish in Afrikaans. Since he wanted to reach all sections of the South African population (who, in general, are less bilingual than Afrikaners), he published in English.

[2] H. W. van der Merwe, "The Coloureds," New Nation (June, 1971), p. 10.

In a recent public survey by Mark-en Meningopnames for the national Afrikaans Sunday newspaper Rapport[1], 1,400 carefully selected "white" Afrikaners were asked whether they considered Afrikaans-speaking Coloured people (the great majority of Coloured people speak Afrikaans as their first language) to be Afrikaners? The overall result was that 45% said, "Yes, they are Afrikaners," 36% said, "No," and 18% were unsure. Rather surprisingly, perhaps, the majority of "Yes" over "No" votes rested upon the women's vote. Men voted 40% "Yes" and 43% "No." The lowest percentage of "Yes" votes was among young men 18-24 years old, where the "Yes" percentage was 34 and the "No," 44.

Among women, the oldest and the youngest groups were most strongly inclined to accept Coloured people as fellow Afrikaners. Afrikaans women over 55 voted 50% "Yes" and only 19% "No," with the remaining almost one-third unsure. Young women 18-24 were more definite in their responses, showing 52% "Yes" and 30.5% "No."

Province	Yes	No	Uncertain
Cape	51.4%	28.3%	19.4%
Transvaal	41.9%	40.4%	16.8%
Free State	37.5%	40.5%	20.0%
Natal	44.5%	37.0%	18.5%

Many surmises could be made from this survey. It is obvious most "white" Afrikaners consider Coloureds to be Afrikaners in the cities where there is a higher concentration of Coloured people. The vote by ages may suggest that there once was an attitude, perhaps traditional, towards Coloured people as ons bruin mense ("our brown people"), which influenced older women, while modern day liberal attitudes account for the views of the younger ones. Sexual rivalries may play an undetermined role in some of the answers. The younger men may feel a greater sense of exclusivity as a result of what they are taught in school, but grow more tolerant with age and experience. All of these possibilities, of course, are speculative.

Dr. van der Merwe quotes one of the Afrikaner statesmen of the last generation, the late Dr. A. L. Geyer, in what is a candid articulation of the quandary many middle-of-the-road Christian Afrikaners find themselves in--the "uncertains" in the above survey. Geyer said,

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[1] Translated from Rapport (March 26, 1972).

"When I think of the Coloureds, my thoughts arrive at a dead end and I prefer not to go any further. While High Commissioner in England I always preferred to give talks on the Africans rather than on the Coloureds because in the case of the Africans I knew the answers."[1]

In these brief observations on contemporary Coloured politics, it is essential to note that the majority of the elected representatives of the Coloured Representative Council are members of the Labour Party and resolutely oppose any division of South Africa which purports to give the Coloured people a "homeland."[2]

Finally, the able leader of the majority Federal Party in the Coloured Representative Council, Mr. Tom Swartz, who is often referred to as the "Coloured Prime Minister," has been forced into increasingly militant statements on behalf of the Coloured community. After the visit of the American Negro head of the NAACP, Mr. Roy Wilkins, Swartz said, "We want real power. Mr. Wilkins convinced me we can never have any in our own country without a vote. We may be equal citizens of South Africa sooner than you think."[3]

A pamphlet (now rare) entitled Miscegenation[4] was published by George Findlay in 1936. Mr. Findlay was convinced that there was a very wide descrepancy between the number of light-skinned Coloured people one would expect to find in the Coloured community with the actual number he found. In his pamphlet he attempted to estimate the number of "Coloured" people who had "disappeared" into the "white" community.

Although Findlay's study, begun in 1927, cannot be accepted as good scientific study today, there is little doubt that "trying for white"

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[1] H. W. van der Merwe

[2] As stated to the editor in Cape Town, April 1972, by Mr. V. D. Curry, Deputy Leader of the Coloured Labor Party. Mr. Curry reiterated this statement in May 1972, during a visit to Pasadena, California.

[3] Sunday Tribune (Durban, April 9, 1972).

[4] Miscegenation, A Study into the Biological Inheritance of the South African European Population by George Findlay. Pretoria: The "Pretoria News" and Printing Works Ltd., 1936.

(the South African phrase for "passing for white" in America) was a common phenomenon of the years between World Wars I and II. A usual practice was to move from the Cape, which was divided into white, Coloured, and African categories, to such a metropolis as Johannesburg in the Transvaal, where the distinctions were primarily white or African.

Despite the lack of rigor in Findlay's analysis, it stands out in South African history as one of the earliest honest attempts to study the question of the genetic composition of part of the white population. Findlay was overconfident of his ability to visually distinguish various degrees of "Coloured blood" in the populations of Cape Town and of Johannesburg. Yet he is probably correct that "to the Bantu and coloured folk in Pretoria, the process of escape is a common everyday affair."[1] Findlay uses an expression common for that age, the "venstertjies," which indicates those Coloured people "passing for white" who, when seeing a Coloured friend, conveniently looked into a store window so as to avoid what might be an embarrassing confrontation. According to Findlay's estimates, some 600,000 light-skinned Coloured people had "escaped into the European category to balance the 600,000 remaining beyond the colour-bar." When he published his study in 1936, Findlay estimated that some 733,000 whites out of the population of 1,167,000 whites carried the "taint of colour." This is a far higher figure than was politically acceptable to white politicians of that day. Although Findlay used what is now archaic terminology, he was by no means critical of sexual crossings. But as he grew older, he became concerned that his revolutionary opinions would involve him with the law. When I tried to interview him in the 1950s, Findlay was extremely defensive and refused to discuss his earlier work. This was during a period of a strong government drive against the Communist Party in South Africa. The last publication of Findlay's in the Munger Africana Library is dated Pretoria, July 1944. It is a booklet embodying three lectures Findlay delivered that year to the Left Club in Johannesburg on "Communist Theory and Practice."

Credit must be given to the South African government for the recognition that has finally been made of the Coloured communities of the Transvaal, Orange Free State, and Natal. It is quite revealing to contrast conversations with Coloured leaders in these three provinces

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[1] Miscegenation

with some Coloured leaders in the Cape. The original "Cape Coloured" have tended to look with some arrogance towards the less well-educated Coloured communities elsewhere. Furthermore, however harsh the lot of many Coloured people in the Transvaal, they have not suffered the steady erosion of their political rights as has happened in the Cape. They had no rights in the Transvaal to begin with! It is not surprising that the general feeling of bitterness and despair so often found in Coloured people in the Cape is not true of the Coloured suburbs of Johannesburg. There is a certain buoyancy present there, where people are voting for Coloured men in some sort of a representative body for the first time; young people are gaining academic honors; and Coloured employment is booming, compared with the slower growing economy of the Cape.

A great deal of secrecy has surrounded the genetic composition of both the Coloured people and, even more, the Afrikaans-speaking whites. It was not until a doctoral thesis at the University of the Orange Free State went into great detail that it became accepted in intellectual circles that the famous leader of the Afrikaners, President "Oom Paul" Kruger, had some Coloured ancestry as was shown in his genealogical records. Not many South African school children know that the first South African-born Governor-General, Simon van der Stel, was the issue of a Dutchman and a dark-skinned lady from India.

One of the tragedies of the Coloured people is that too often others have tried to speak for them, with the exception of such distinguished men as Abdurahman. Some of the anguish of the Coloured people is best expressed in the books by Peter Philander, a Coloured poet who writes in Afrikaans. Before he fled to the United States, Philander won the annual prize given to the best Afrikaans poet. Among the Coloured intellectuals remaining in South Africa is Adam Small, head of the philosophy department of the University of the Western Cape. Mr. Small's views have been expressed in these Notes.[1] In an earlier article, Small poured scorn on the government's system of electing some Coloured representatives but appointing enough others, in an ironic copying of British colonial tradition, to ensure one-vote majority for the supposedly "pro-government" Federal Party.[2]

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[1] Adam Small, "A Brown Afrikaner Speaks: A Coloured Poet and Philosopher Looks Ahead." Munger Africana Library Notes, (October, 1971).

[2] Adam Small, "The Coloured Elections," New Nation, (November, 1969).

The six-year study of genetic blood types made by Dr. M. C. Botha of the famous Groot Schuur Hospital in Cape Town was not conducted to create headlines or to make political capital. Dr. Botha was drawn to the study by compassionate scientific reasons. The brother of a prominent Afrikaner politician was incorrectly treated for a blood disease, and subsequently died as a result. It was not recognized when he was treated that he had a blood disease scientifically associated with the African people of South Africa.[1] Dr. Botha, who was immunologist to Dr. Christian Barnard, was not seeking publicity in undertaking his study. He was interested in saving human lives.

The general assumption in South Africa has been that the Afrikaner has perhaps 1% "non-white" genes in his makeup. This figure was derived from the conclusions of Dr. H. T. Colenbrander in 1902. Botha found that the Cape Town Afrikaner (and probably the English-speaking Capetonian) has almost 7% "Coloured blood."

By a remarkable coincidence, Dr. A. J. Heese, the former archivist of the Nederduits Gereformeerde Kerk, quite independently, in a long scholarly examination of marriage and birth registers, investigated the possible commingling of "Coloured blood" among the Afrikaners. Amazingly, Dr. Heese's just-released conclusion is that Afrikaners were 7% "Coloured" in ancestry, whereas Dr. Botha, by entirely different methods, concluded that the Cape Town Afrikaners in ancestry were 6.9% "Coloured."

Dr. Botha commented, "My study proves that the Coloureds have 36% southern African blood, while we whites have 7%. Therefore, the Coloured people have only 29% more Coloured blood than we have. So where is the big difference between us? Is 29% sufficient to divide us into different races? I think not. The fact is that the Coloured people are just a little less pure than we are."[2]

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[1] Dr. Botha states, "The drugs with which he was being treated merely aggravated the disease and killed him. If the correct diagnosis has been reached, his life would have been saved."

[2] Sunday Times (Johannesburg, March 26, 1972).

The editorial board of the Munger Africana Library Notes has chosen to reprint this supplement to the South African Medical Journal (with the permission of the editor, Pieter Von Biljon, and the author) because it throws valid scientific evidence on a subject so often prey to prejudice and emotionalism. In addition, the board believes that most of the Africanists who read this publication would not otherwise have become cognizant of such a valuable scientific study.

E. S. M.

Comments on the Biological Facts of the Study

by

Ray D. Owen, Professor of Biology
California Institute of Technology, Pasadena

The blood groups that characterize individual human beings provide the student of population structure and relationships with exceptionally useful data. The virtually unique value of blood group determinations arises from a number of considerations. First, the determinations are made by objective tests, and the outcome of the test is either positive or negative for the reaction of any person's blood with any particular reagent. Second, the tests are readily repeated for the detection of any possible errors in test, recording, or analysis. Third, with rare exceptions a blood group is related directly to a particular genetic factor; its detection does not depend on the environment in which the individual developed or on his present condition of health or disease. Finally, the genetic control of a particular blood cell specificity is extraordinarily simple; with rare exceptions, a test result reflects the presence of a gene that controls that result.

The authors of the careful and comprehensive work reported in the paper under consideration have taken full and critical account of the advantages of blood group analysis to cast light upon the relationships of Cape Town populations. They have been careful in the ways they have drawn conclusions; have recognized and specified the main uncertainties in their data, analyses, and conclusions; and have presented their results with clarity and interest. Their citation of related literature represents, in itself, a valuable bringing together of similar studies from the past. Altogether, this is a paper of unusual scope and interest, representing a great deal of hard competent work and well worth anyone's reading.

Blood Group Gene Frequencies*

AN INDICATION OF THE GENETIC CONSTITUTION OF POPULATION SAMPLES IN CAPE TOWN

M. C. BOTHA, F.R.C. PATH., *Pathologist-in-Charge,* IN ASSOCIATION WITH JUDITH PRITCHARD, M.T., *Principal Medical Technologist, Provincial Blood Grouping Laboratory, Cape Town*

SUMMARY

Blood group gene frequencies were determined for four population groups at the Cape. The frequency patterns were compared among these populations and also with blood group patterns of the original stock.

The Afrikaans-speaking and English-speaking populations do not differ significantly from one another in this respect, but both these populations do differ, in a manner which is statistically significant, from Western European populations, with respect to two major blood group systems. The explanation for this genetic difference is that both the Afrikaans-speaking and English-speaking White population groups, as defined in this study, possess a minor proportion of Southern African genes. This observation may be due, in greater or lesser part, to the presence in the sample of individuals who have relatively recently been taken up into the White population. The combined evidence of blood group studies and historical records suggest that the Afrikaans-speaking people (investigated at the Cape) possess a measurable genetic contribution from the indigenous peoples of the old Dutch East Indies.

These conclusions provide an acceptable explanation for the occurrence in these two sections of the population of certain genetically determined diseases which are not characteristic of Western European populations.

When the Cape Coloured people are subdivided on the basis of religious faith, the Cape Malay and the non-Malay Coloured population groups differ fundamentally in their blood group gene frequencies. This difference is a reflection of a similar but wider divergence between the blood group patterns of Indian and South-East Asian peoples on the one hand and Southern African peoples on the other; nonetheless, the blood group gene frequencies of the two Cape Coloured population groups are distinct from Southern African and Asian gene frenquencies, mainly as a result of intermixture between them, and an important European genetic component in both sections. On this basis the Cape Coloured population is either a new race, or embraces two new races. Taken as a whole, the Cape Coloured community possesses a blood group pattern which could be constituted by approximately 34% Western European, 36% Southern African and 30% Asian genes.

The occasional occurrence of abnormal forms of haemoglobin (Hb - C, Hb - E and Hb - S), and of glucose-6-phosphate dehydrogenase deficiency in the Coloured and White populations of the Cape raises the question of the racial constitution of these regional populations.[1-3] These conditions, and the diseases they cause, are directly under genetic control, and have ethnic associations. The disorders are virtually absent from West European populations, but occur variously in Mediterranean countries, the Middle East, South-East Asia and among the indigenous people of Africa.

The Coloured people of the Cape form an anthropologically distinct population group whose relatively recent origin includes Eastern and European elements. The possibility that the White populations of South Africa possess coloured admixture has been asserted on genealogical grounds.[4,5]† For this reason, the genetic constitution of the various population groups requires investigation. Among genetic markers, the blood groups are relatively simple to determine accurately; and accumulated blood group data, obtained in population studies, can be analysed quantitively.

Knowledge of the distribution of blood groups has applications in medicine. It is a ready measure of the genetic relationship among different races. In circumstances where a transfer of genes (and gene-dependent diseases) occurs between races, the blood group distribution in newer populations may be of interest to social and anthropological science also. This is particularly so when the blood group pattern of the original stock is known. In South Africa the White population may perhaps, and the Coloured people can certainly, be considered in this context.

*This study was completed and in transcript by November 1966.

†After the serological and early statistical part of this study had been completed, the observations led to an examination of historical records. During the final stages of this part of the investigation, Dr J. A. Heese, of the Dutch Reformed Church Archives, interested himself in our pursuit and gave us access to the results of a very comprehensive genealogical study on which he had been engaged for some years. Very generously, Dr Heese suggested that we refer to a completed but unpublished second part of his research (the first part was not immediately available). Liberal use has been made of this offer, since Dr Heese has collected and analysed information not available elsewhere than in scattered original church and civil registers. At the same time it must be understood that Dr Heese's investigation and the one reported here were undertaken and pursued quite independently; and that Dr Heese has in some respects a prior claim, since the first part of his project came to a conclusion earlier than this study.

PREVIOUS STUDIES

Except for the Bantu,* published figures for the distribution of blood groups within the different South African population groups are scanty. Extensive reports of blood group patterns of the South African Bantu are available, but these are not relevant in a genetic study of the Cape regional population, since Bantu people did not form part of the early Cape settlement, or of the established community of the Western Cape, until comparatively recently. Information about blood groups among those South African populations which are relevant in this local study were generally obtained on small and scattered samples.

Pijper reported[6] in 1929 on the ABO groups of 596 South African Dutch in the Transvaal, and in an early report from this area, Altmann and Gaynor Lewis stated[7] that the White population has the same rhesus group and subgroup distribution with anti-Rh_0 (anti-D) and anti-Rh_1 (anti-C) as other European populations. Shapiro reported[8] on the Kell/Cellano blood group among 536 South African White persons, and the same author studied the inheritance of the MNS group system among Cape Malay, Cape Coloured and White people; special attention was directed to the Henshaw factor, and its absence from 1 000 White individuals was reported.[9] Zoutendyk[10] provided information on the ABO blood groups of 135 Coloured (mixed) individuals without further definition of the population or locality. Pijper,[11] with subsequent comment by Elsdon-Dew,[12] reported the ABO blood groups of 506 Hottentots. Grobbelaar stated[13] that the Korana were found to have a similar ABO blood group pattern to Hottentots studied by Pijper. Zoutendyk *et al.*[14] gave information on the ABO and 5 additional blood groups systems in 213 Hottentots; and, more recently, Singer *et al.*[15] reported extended blood group results on about 44 Hottentots which were considered relatively more pure than the population samples of the earlier reports. Reports on Bushmen blood groups are those of Pijper,[16] Zoutendyk *et al.*,[17] and Weiner and Zoutendyk.[18]

In a comparative study, Shapiro,[19] using the Rh gene frequencies of a sample of 450 Coloured persons from the Kimberley area,† concluded that they represented a mixture of approximately 42% White and 58% Bantu. However, re-evaluation of the method which the author provides for estimating the percentage mixture in hybrid groups, as well as recalculation of the data provided in this study, makes this conclusion doubtful. In the author's method of plotting the data, a linear decrease in the White genetic contribution to the hybrid may have been interpreted as an increment. Also in this report is a diagram of blood group distribution among various population groups, which includes South African Bantu, Kimberley Coloureds and Whites; without discussion, the author states that the diagram shows the effects of miscenegation between Whites and Negroes on the Rh gene distribution as it has occurred in South Africa.

As regards the substantial proportion of the South African population which lives in the Cape Peninsula, two studies on blood group distribution are available. Neitler[20] reported the relatively high frequency of Fisher's D (Rh_0+) factor among Coloured, as compared with White, patients in the Cape Town area. When the present report was already in preparation, Gordon[21] published observations on the blood group pattern of the Cape Coloured population and offered tentative conclusions regarding racial admixture. These observations were based on blood grouping tests which were initially undertaken to provide the final part of the present study.

Bronte-Stewart *et al.*[22] reported on the ABO blood group distribution in the Afrikaans-speaking, the English-speaking Gentile, the Jewish and the Coloured population groups of Cape Town and environs. These figures for ABO distribution were obtained from a large series, consisting of new blood donors, subdivided in the first instance according to skin colour. The White donors were further subdivided on the basis of professed religious faith into 3 groups: Jewish; Afrikaans-speaking if they belonged to the Dutch Reformed group of churches; and English-speaking if membership of the Anglican, Methodist, Presbyterian and Congregational churches was professed. This subdivision left a minor unclassified group.

The Jewish group was considered to be clearly defined by these criteria. They form a homogeneous population derived mainly from the immigration of Ashkenazim Jews from Central and Eastern Europe at the beginning of the present century. Their ABO blood group pattern was similar to that of their race of origin.

A minor difference was reported in respect of the ABO groups between the Afrikaans-speaking and English-speaking population; and the Coloured population was found to have a distinctive pattern. During the study it was noted that both the White population groups of the Cape differed in ABO blood group distribution from the races of Western Europe. These observations in respect of the White (Gentile) population and the Coloured population were investigated further and form the basis of the present report.

THE WHITE AND CAPE COLOURED POPULATION AT THE CAPE

The Gentile White population of the Cape Peninsula is not regarded as a homogeneous group, being broadly divisible into Afrikaans-speaking, English-speaking, and a remainder. There are certain differences between these groups in language, outlook, occupation, temperament and religious faith. The census returns do not achieve a distinction, the figure for the total White population in 1960 being 305 158.

*The terms *Bantu-speaking Negro* for Bantu, *Khoikhoi* for Hottentot and *San* for Bushmen were recommended as racial epithets by those attending a Symposium on Man in Southern Africa, held in Johannesburg in July 1971, under the auspices of the South African Institute for Medical Research.

†The use of the designation 'Coloured' for those circumscribed South African communities which are known to be of Bantu and European descent, required careful interpretation. On general grounds these small separate collections were recognized as differing from the 'Cape Coloured'.

The Cape Coloured population totalled 417 881 in the same year. Again, the census does not take account of the existence of two sections in this group, the Malay and the non-Malay.* The Cape Malays belong to the Moslem faith, which demarcates the group also in respect of other cultural characteristics. Since the Moslem religion was introduced to the Cape from the East, the Cape Malays evidently retain at least cultural characteristics which were not indigenous to South Africa. The non-Malay Cape Coloured, when subdivided from the Malay on the basis of professed religious faith, form a hybrid group distinct from the White population on the anthropological measure of skin colour. However, a minor proportion of the non-Malay as well as the Malay Coloured population cannot be subdivided from the White population on this criterion.

Historical Background

Traditionally, the White population groups came from Western European stock; and on historic grounds, the origin of the Cape Coloured is found in three main ethnic groups: the Southern African races and immigrants from Asia and Western Europe.

Southern African: Of the indigenous peoples of Southern Africa, the nomadic Hottentots were of overriding importance in the development of a new population at the Cape. They were present from the date of the founding of the settlement (1652), and except for relatively short periods of hostility, they remained more or less in daily contact with the immigrant people.[23] Within 30 years the local tribes had been dispossessed of their grazing rights[24] and with the rapid growth of the Colony they were dispersed by the settlers. Many groups were subsequently decimated by epidemics, including smallpox (1661, 1663, 1713, 1755, 1767).[25-27] As early as 1666 (14 years after the first Western European settlers and South-East Asian arrivals) 80 Hottentots are recorded[26] as being part of the settlement; and in 1810 there were about 660 men and 645 women classed as 'Hottentots' in Cape Town and the Cape district. The totals for the Cape of Good Hope, which included the districts of Stellenbosch, Swellendam, Tulbagh, Graaff-Reinet and Uitenhage were about 10 000 'Hottentot' men and as many women.[28] This did not mean pure Hottentots, since references to 'Bastard Hottentot' and 'Javanese Hottentot' were made at the time.[29,30]

In contrast, contact with the Bushmen and the Bantu-speaking Negroes came later and at the boundaries of the settlement, which were then distant from the Cape in point of time. Although the Dutch became familiar with them early, the Bushmen always remained remote from the settlement. Officials or colonists came across them occasionally at the outposts or beyond. This contact assumed importance only well within the 18th century, and was soon marked largely by mutual hostility.[31] Nonetheless, in the border areas many Bushmen, including women and children, were taken captive and retained as servants for periods of 10 - 20 years. The first of several large punitive expeditions captured 241 men, women and children along the northern and north-eastern frontier (Bokkeveld, Roggeveld and Sneeuberg) in 1774.[32] As soon as the prohibition promulgated in that year against the carrying off of women and children was enforced, enthusiasm for expeditions against the Bushmen declined.[31]

Social contact with indigenous Bantu-speaking Negroes also dates from late in the 18th century. Bantu families moved to the eastern frontier in 1774 and, in spite of prohibitions in this respect, it was reported officially in 1777 that a few colonists beyond the Great Fish and the Bushman rivers were living close to these people.[33-35] Official regulations and supervision did succeed in limiting contact with the Bantu until the 19th century.[36,37]

Other Southern African people who arrived at the Cape after 1652 in substantial numbers were Negro or negroid slaves. The first slaves to be imported in significant numbers were two shiploads from the West African coast (1658). They were 170 from Angola and 228 from Guinea, mainly young boys and girls. Of these, 102 were shipped to Batavia in the same year.[38] Later records contain only an occasional reference to West African people.

From 1670 onwards, and mainly during the 18th century, considerable numbers were brought from Madagascar and the East African coast. Importation from Mozambique was officially attempted mainly between 1721 and 1730. Comparatively few were obtained from this source by the Dutch East India Company during this period.[39] Regarding Madagascar, it is not easy, and perhaps impossible, to determine the total or even relative numbers from this source over the whole period of importation, but these were certainly substantial.

Asian: This racial component was introduced to the Cape by slaves and political exiles in the 17th and 18th centuries. Although their descendants are traditionally known as Cape Malays, these involuntary immigrants from Asia came, not so much from the Malayan Archipelago, as from other Dutch possessions: the Sunda Islands (part of the present-day Indonesia), the Moluccas, Ceylon, India and Bengal.[40] The proportionate distribution of various Asian peoples among the slave population of the 17th and 18th centuries is not known.

Modern reviews state that the majority of slaves came from Madagascar.[41] This conclusion bears re-examination. Importation from Madagascar was undertaken officially by the Dutch East India Company and each batch of slaves was accounted for in official records.[42] The same applied to cargoes of Madagascar slaves on board enemy ships, taken and landed here as prizes of war.[43] Only occasionally was it possible for the Council of India to send a batch of Eastern slaves officially to the Governor at the Cape, and this was then documented in the same way as were the arrivals of Asian political exiles.[44] Official records for 1672 - 1682 give account of 5 batches totalling 569 Madagascar slaves; in this period 2 batches from the East are recorded. Due to contradiction in documentary sources,[45,46] it is not clear whether the Asians amounted to 140 or 230 individuals. In either event, the total is appreciably smaller than that from Madagascar. However, the Eastern slaves were not always imported in batches as

*In the 1970 census returns there are 598 952 Coloured persons in the Cape Peninsula, i.e. in the magisterial districts of Cape Town, Bellville, Wynberg and Simonstown. According to the Secretary of the Muslim Assembly there are approximately 60 000 Muslims in this area. The rate is therefore about 1 in 10.

were those from Africa. Many came as house-servants and personal attendants with Western Europeans on their way home from the East Indies,[46,47] or were brought as speculative investment.[48,49] They were left at the Cape since there were no slave markets in Western Europe.[48,50]

The difficulty in using historical records to determine proportionate numbers of the different nationalities arises from the stratification which existed in the slave community. Negro and negroid slaves were cheaper and used mainly for unskilled labour;[51] their numbers predominate in official records such as those reflecting ownership by the Company. Eastern slaves were more popular as household and personal servants, or as skilled labourers.[52,53] A proportion was contracted out to work on their own account.[54,55] The majority of recorded manumissions of slaves and references to freed slaves relate to Sundanese, Indian and Bengalese individuals or to the Cape-born slave children of such females.[40] Lists of slaves are therefore not representative, whether these appear in auction rolls, criminal rolls or official returns.

Our analysis of official slave lists[56] for 1802 shows that the Company owned the following slaves: from Madagascar 91; Mozambique 161; and others, mainly Asiatics, 67. In contrast, scattered throughout the Requesten and Memorials[40] addressed to the Governor and Council during 1715 - 1806 are recorded 1 290 slaves and 'free blacks' by name and origin, as follows: Madagascar 20, Mozambique 8, Asia 774, and from the Cape (i.e. Cape-born) 482. We could not allocate an exact origin for the Asiatics in every instance, but it would be approximately: Sundanese Islands 409, Bengal 199, coasts of India (Malabar and Coromandel) and Ceylon 166.

On the evidence scattered through early records, it cannot be questioned that the South-East Asian and Indian people, slaves and political exiles, were predominant over the other non-European peoples in exerting a cultural influence on the expanding population of the Cape. Their social conduct, regulated by their Moslem faith, their non-negroid appearance and their previous contact with European culture in the Dutch East Indian settlements, determined their particular place in the Cape society. It would seem that they lived in closer social contact with the early Western European population than either the other slave populations or the indigenous races.

The indigenous Southern African population was never taken as slaves.[57-59] Foreign male slaves, and their Cape-born male descendants, always exceeded the female slaves in number (Fig. 1) and mixed freely with the Hottentot population.[60,61] The offspring of slaves and Hottentot women were not born in bondage, and could therefore be taken up into the free community.[29,62,63]

Western European: The introduction of permanent immigrants was a continuing process, initiated from the Netherlands, with a lesser increment from France during the 17th century, maintained by the Dutch and by Germans in the 18th century and mainly also by the British in the 19th century. In addition to the settlers at the Cape, there was at all times a comparatively large number of temporary officials, garrison and transient visitors. In the first year (1653), residents amounted to 173 in number; and at this time about 7 000 sailors called each year.[64]

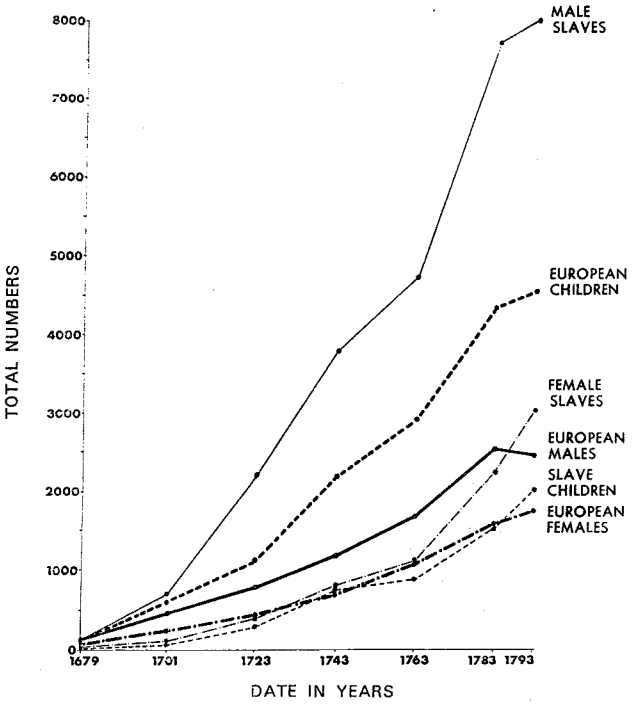


Fig. 1. Total numbers of European residents and slaves at the Cape between the years 1679 - 1793.

Between 1700 - 1793 the number of ships which called at the Cape in any one year varied between 55 and 198. From 1772 to 1793 it was always more than 100, with a single exception (1781).[65] During a period covering several generations the disproportionately small number of women in the Western European population group at the Cape (Fig. 1) was a cause of constant official concern.[66]

As regards intermarriage, that between the Dutch and French had been officially encouraged.[67] In this respect, it is of note that the Germans in the 18th century came mainly from the border areas which were only subsequently incorporated into the German Empire. Of Lower Teutonic stock and Calvinist in faith, they were not Dutch subjects by birth, although most of these immigrants are recorded in their places of origin as having been Dutch. The German immigrants could therefore be readily assimilated by the Cape settlers, an important consideration in view of the very small proportion of Germans among women immigrants.[68]

Marriages between the Western European population and individuals, professing the Christian faith, of other population groups received social and religious sanction in the early days. The considerable number of children which resulted from such marriages, were accepted into the White community.[69] Sixteen of the earliest marriages at the Cape were recorded[70] by the Council of Policy. From the original records it is clear that of these, 13 marriages were between Dutch males and females, while a Dutch male immigrant was married to a freed Batavian woman in two instances and to a Hottentot woman in another.

During the 35-year period 1756 - 1791, the settler population increased from a total of 5 123 to 13 028.[71] The rate of natural increase was high in view of the prevalence of large families.[72] Taken as a random sample of this period of rapid increase, the original marriage records of the Cape itself (i.e. excluding the rural congregations)[73] for the 10-year period 1757 - 1766, indicate that about 1 in 16 (i.e. between 6 - 7%) of all marriages of Western European men, or their male descendants, were with women who are specifically stated to be of slave, or perhaps other Asiatic, origin. These women, whether brought to the Cape or born here, may have had more or less European 'blood'.

In 1685 the Commander of the Cape was instructed that marriage between Netherlanders and emancipated female slaves was not permitted, but this restriction stated that it did not apply to children of female slaves by Dutch fathers.[74]

Several attempts were made to prevent and prohibit irregular unions between Europeans and slaves for moral and commercial reasons,[74-76] but without success.[48,77,78] In 1671 there were 12 children of European men and female slaves in the school,[75] and at that time three quarters of children born to slave mothers were of European fathers.[79] In 1685 there were in the Company's slave lodge alone 58 such children.[74] Both in 1671 and 1685 instructions were given for the education and freeing of such children: in the latter year special provisions were laid down in the event of any of the 26 slave daughters of Dutch fathers wishing to marry a Netherlander. These marriages were conditional on the man being of good character, capable of supporting a family (a point of which the Commander and his Council had to satisfy themselves) and both parties had to profess Christianity and be baptized.[74,75] Children from such unions received statutory recognition as free burgers 'in the right of the father'[80] and were apparently so accepted until 1791.[81]

Theal[82] has taken account of the nationalities of all the Western European men and women who settled at the Cape before 1700, and of all the men who brought wives to the Cape or married here before 1795. At the latter date, shortly before the advent of the British, the colonists numbered 1 300. On this information, it was estimated that the ethnic proportions at this time were seven-twelfths Dutch, one-sixth each of French and German and the remaining one-twelfth of other European (mainly Scandinavian and Swiss) blood. According to Colenbrander,[83] however, the ethnic composition of the Afrikaans-speaking population, as determined by the study of family records up to 1807, is Dutch 50%, German 27%, French 17% and the rest (mainly Flemish, Scandinavian, Swiss) 5,5%. The slave component is barely 1%. The admixture of Scottish and English blood after 1806 would have been largely confined to the colonists' families of the Western Cape. Heese[5] points to the deficiency in the sources[72] used by Colenbrander, and making exact calculations based on original records of marriages, births and subsequent uptake of descendants into the White population, gives the following proportion for the period 1657 - 1807: Dutch 37,9%, German 35,5%, French 13,6%, Coloured 6,9%, other nationalities 2,9%, unknown 3,2%, and British nil.

As regards the British, Hockley[84] stated that in 1819 the colony consisted of 47 000 Whites, 30 000 Hottentots and 35 000 slaves. The British probably formed 4 000 of the permanent population. During 1820 - 1821 a total of approximately 5 000 British settlers arrived; a numerical breakdown of the 4 000 official settlers shows the disproportionate number of 1 455 adult men to 795 adult women. Previously, in 1817, 200 unmarried men had arrived from Scotland.

Heese[5] refers to the substantial immigration between 1808 - 1837 and stresses that in addition to the British, many Germans, Dutch and French continued to arrive. However, of the immigrants in this period the British made the biggest contribution to the Cape colonists. Heese states that when the genealogical calculation for the first 30-year period of British influence at the Cape is brought into relation with the period before 1807, the ethnic composition of the Afrikaans-speaking population (as they may be regarded from this date) in 1837 was: Dutch 37,1%, German 35,0%, French 13,1%, Coloured 6,8%, British 1,6%, other nationalities 3,0%, and unknown 3,4%.

Intermarriage between colonists and British immigrants occurred from an early stage. Many of the early Scots founded Afrikaans-speaking families. In a sample of marriages for the period 1807 - 1837, Heese analysed 600 unions between Cape-born individuals. Following up the descendants, it was found that about 310 of these marriages contributed to the subsequent Afrikaans-speaking population, and 290 to the English-speaking group. Heese further calculates that within 30 years, the contribution of British 'blood' to the Afrikaans-speaking population reached 1,6%. If the intermarriages were divided equally, as seems to be the case, the relatively much smaller British population (9 000 out of 43 000 in 1820) would have received a significantly higher proportion of Dutch-German-French 'blood' than 1,6%.

As regards Coloured intermixture during the period of British settlement, new factors come into consideration. Previously, in 1786, the colonists had expressed, as a matter of policy, strong disapproval of the racial admixture which was taking place with the indigenous Coloured population in the border areas;[85,86] importation of slaves from the East ceased in 1767, and all importation was abolished in 1807; and in 1817 the Church at the Cape made an official declaration against racial intermarriage involving White persons.[69] Heese[5] states that illegitimate children of mixed origin from the original colonists were still recorded in church registers during the latter period (1807 - 1837) of his study, but these were rarely taken up into the White population group; and the same applies to the descendants of the marriages between the newer immigrants and the Coloured population. Such marriages occurred mainly on the frontiers, and the borders of the Colony by this time were far from the Cape itself. Although the absolute overall rate of recognized marriage between White and Coloured had decreased markedly between 1807 - 1837, it occurred relatively more frequently between the British and other new immigrants on the one hand, and the indigenous Coloured population on the other. Heese ascribes the lower rate of uptake into the White population of the descendants of these marriages to their strong physical resemblance to the mother's race. Such discrimination had not been applied previously to the same extent, to the

descendants of marriages between Western Europeans and Southern Asians. However, according to Heese, recognized marriages producing descendants acceptable to the White population of the border areas did take place between settlers or colonists and Coloured women who were already of mixed origin.

THE PRESENT STUDY

In our previous blood group study, a minor difference was found in the ABO blood group distribution of the Afrikaans-speaking and English-speaking sections of the Cape population. The reservation was expressed that these two population groups could not be considered to be subdivided as clearly as the others, i.e. Jewish and Coloured. In addition to long-standing cultural intermingling, there has been genetic admixture through intermarriage. For this reason a further investigation into the blood group distribution of these two groups was indicated, using cultural criteria other than religious faith. Two additional means of subdivision were available: family names and language.

The Afrikaans-speaking population generally have surnames which indicate an origin from Dutch, French or German stock. The English-speaking (non-Jewish) group have surnames which are recognizably those of England and Scotland, and to a lesser extent, Ireland and Wales. Attendance at local government schools generally results in separation between Afrikaans-speaking and English-speaking groups according to the language medium of instruction.

A study was undertaken, and is here reported, to determine the ABO blood group distribution among a random population sample at the Cape. In the first instance, this again consisted of Coloured and White blood donors. The Coloured group was defined as previously; the Afrikaans-speaking and English-speaking groups were separated on the basis of recognizable surnames. The two methods of separation, by name and by religious faith, were compared within the sample. In addition, further comparison was sought, within the White population, between groups of Afrikaans-speaking and English-speaking (non-Jewish) school children (subdivided by language); and within the Coloured population, between groups of Malay and non-Malay school children and factory personnel (subdivided by professed religious faith). This required blood samples to be collected specially and the opportunity was used for determining additional blood groups, other than the ABO groups.

Donors Studied

The enrolment forms for prospective blood donors of the Western Province Blood Transfusion Service during the period 1959 - 1961 were used in the first part of the study. This provided, among others, the following particulars: surname, sex, marital state, whether of White or other race, whether the person had donated or received blood previously; and the ABO and Rh group. During the period under study these blood groups were determined on duplicate samples in two independent laboratories.

Forms which did not provide the stipulated information clearly were discarded from the analysis, as were forms from persons who may not have been recruited at random, e.g. medical practitioners, blood transfusion workers, etc. Women who were not clearly stated to be single were excluded on the grounds of change of name as well as a possible prior knowledge of their blood group through antenatal blood tests. For the latter reason, all persons who had received or had previously donated blood were excluded.

The remaining forms were then divided into those of White and those of non-White donors. Further subdivision was made as follows: forms from non-White donors which stated the donor's race to be anything other than Coloured or 'mixed' were discarded; this relatively small number consisted of Asiatics and Bantu. The remaining sample was considered to be representative of the Cape Coloured. The enrolment forms from male and unmarried female White donors were subdivided into 3 categories: (1) those with surnames which were considered to indicate the Afrikaans-speaking group; (2) those with surnames which were thought to indicate derivation from British origin; and (3) a category of surnames which the authors could not reasonably classify by these two criteria. Each of these 3 categories was large enough to be further separated into 2 classes: (*a*) a resident population; and (*b*) a population which is likely, in part at least, to be non-resident, such as students at universities, members of armed forces camps, inmates of corrective institutions and the like.

After the O, A, B, and AB groups had been counted in each of the 6 classes among the 3 categories, the White donors in the 3 resident population groups were asked by letter to which church they belonged. The replies were divided into 3 categories, according to churches, as in the previous study.

Students and Schoolchildren Studied

Four Coloured schools, of which 2 were specifically Moslem schools for Malays, 2 Afrikaans-medium schools, 2 English-medium schools and 2 parallel Afrikaans- and English-medium schools were visited. Blood obtained by finger-pricking was taken into normal saline from pupils who had parental consent. The consent rate varied between 88 - 100%, from school to school. Of siblings, only one was included. At factories blood was taken by venepuncture. The specimens were examined on the day of collection for the ABO and other blood groups, as shown in the tables.

METHODS

Blood grouping tests were carried out by 2 senior technologists using standard methods and reagents. All the blood grouping sera were tested independently in at least one other laboratory. From nearly all batches of specimens, selected samples were re-tested with anti-C, anti-D, anti-E, anti-e, anti-c, anti-M and anti-N, anti-Kell, anti-Fy^a and where necessary, anti-globulin sera, which were obtained commercially from laboratories subscribing to the stan-

TABLE I. COMPARATIVE TABLE OF ABO BLOOD GROUP DISTRIBUTION AMONG BLOOD DONORS IN THE CAPE

Population	Number tested	Phenotypes %				Genes %			D/σ
		O	A	B	AB	O	A	B	
Afrikaans family names, White donors									
Cape Peninsular civilian	1 369	632	518	147	72				
		46,17	37,84	10,74	5,26	67,24	24,46	8,30	−2,60
Institutions and Armed Forces	1 408	626	561	165	56				
		44,46	39,84	11,72	3,98	66,76	25,06	8,18	+0,31
British family names, White Donors									
Cape Peninsular civilian	1 354	591	556	140	67				
		43,65	41,06	10,34	4,95	65,61	26,45	7,94	−1,63
Institutions and Armed Forces	483	214	219	41	9				
		44,31	45,34	8,49	1,86	67,22	27,45	5,33	+1,66
Unclassified family names, White donors									
Cape Peninsular civilian	791	325	314	103	49				
		41,09	39,70	13,02	6,19	63,56	26,35	10,09	−1,31
Institutions and Armed Forces	328	147	125	47	9				
		44,82	38,11	14,33	2,74	67,81	23,21	8,98	+1,53
Cape Coloured donors									
Cape Peninsular civilian	714	283	223	149	59				
		39,64	31,23	20,87	8,26	62,16	22,10	15,74	−1,63
Institutions and Armed Forces	512	186	182	111	33				
		36,33	35,55	21,68	6,44				
Discarded material									
White donors	2 002	909	795	201	97				
		45,40	39,71	10,04	4,85				
Non-White donors	208	86	57	53	12				
		41,35	27,40	25,48	5,77				

dards of the National Institute of Health, USA. Anti-Diego serum was kindly provided by Dr Layrisse of Venezuela. The anti-Henshaw serum was made in our laboratory and initially tested by Dr A. Zoutendyk; 2 anti-P sera were collected locally and standardized against blood samples previously grouped by Dr Mourant's laboratory in the Medical Research Council Unit, London.

Specimens possessing the Rh antigen D^u were included among those who were D-positive; those of A_2 and other subgroups of A were counted as A.

The formulae for calculating ABO gene frequencies are those used by Mourant *et al.*[87] and Mourant[88] whose methods of tabulating are also largely followed. This method has intrinsic merit, and also permits the information collected from Western Europe, Asia and Southern Africa in their tables to be compared with our observations. Rh gene frequencies were calculated, tested for reliability and compared according to Race and Sanger.[89] In several instances we recalculated gene frequencies from data in other publications to make comparison more uniform.

RESULTS

The results for ABO blood group distribution among new donors with Afrikaans, British, and unclassified names, as well as Coloured donors are shown in Table I. The proportionate number of each of the blood groups O, A, B, and AB is shown, and below it is the percentage frequency of the blood group; the gene frequencies per cent which have been calculated from the percentage frequencies are shown next; and finally a mathematical test of the difference between the expected frequency of group AB and what was actually found. If the value of D/σ does not exceed ± 2, excepting 1 in 20 observations, the population samples may be regarded as homogeneous and the methods accurate.[87]

Analysis of information collected by the questionnaire on professed religious faith is given in Tables II - IV. Tables V - VII provide information on the blood group tests on school children and factory workers, these being subdivided into races as defined. Following Fraser Roberts,[90] the blood group ratios $A/(O+A)$ per cent and $(B+AB)/(O+A+B+AB)$ per cent are given as a sensitive indication of differences in blood group patterns (Table VIII).

TABLE II. DETAILS OF DONORS ASKED ABOUT PROFESSED RELIGIOUS FAITH, AND THEIR REPLIES

	Family name		
	Afrikaans	British	Unclassified
Number asked	**942**	**1 031**	**599**
Group A %	**37,15**	**42,09**	**37,90**
Replies received	**502**	**734**	**339**
Group A %	**34,26**	**41,01**	**33,6**
% returned	**53,3**	**71,2**	**56,6**

TABLE III. ANALYSIS OF RELIGIOUS FAITH PROFESSED BY DONORS SUBDIVIDED ACCORDING TO FAMILY NAME

Family name	Number	'Afrikaans' churches	'English' churches	Hebrew	Roman Catholic	Other faiths	Changed faith	Not professing
Afrikaans	**502**	**364**	**57**	**1**	**10**	**27**	**35**	**8**
		72,5	**11,4**	**0,20**	**2,0**	**5,4**	**7,0**	**1,6**
British	**734**	**61**	**497**	**22**	**91**	**42**	**14**	**7**
		8,3	**67,7**	**3,0**	**12,4**	**5,7**	**1,9**	**1,0**
Unclassified	**339**	**60**	**86**	**67**	**56**	**32**	**28**	**10**
		17,7	**25,4**	**19,8**	**16,5**	**9,4**	**8,3**	**2,9**

TABLE IV. ABO BLOOD GROUPS OF NEW DONORS BELONGING TO DIFFERENT CHURCH GROUPS

	Number tested	Phenotypes %				Genes %			
		O	A	B	AB	O	A	B	D/σ
'Afrikaans' churches	**485**	**232**	**166**	**62**	**25**				
		47,84	**34,23**	**12,78**	**5,15**	**68,56**	**22,06**	**9,38**	**−1,31**
'English' churches	**640**	**287**	**264**	**61**	**28**				
		44,84	**41,25**	**9,53**	**4,38**	**66,61**	**26,20**	**7,19**	**−0,93**
'Afrikaans' name and church	**364**	**175**	**128**	**46**	**15**				
		48,08	**35,16**	**12,64**	**4,12**	**69,18**	**22,06**	**8,76**	**−0,31**
'English' name and church	**497**	**221**	**214**	**42**	**20**				
		44,47	**43,06**	**8,45**	**4,02**	**66,36**	**27,21**	**6,43**	**−0,75**

Subdivision of Donors by Name

The minor differences between the ABO blood group distribution of the Afrikaans-speaking and English-speaking new donor population groups, reported previously on the basis of subdivision by religious faith, is confirmed. The donors with Afrikaans names have a slightly higher frequency of *O* and *B* genes. The distinct ABO pattern found earlier for the Coloured group as a whole is likewise confirmed.

The calculation for error (D/σ) due to possible deficiency of blood group AB is greater than 2 for donors with Afrikaans names. Since this is an isolated instance in a series of tests running concurrently for different population groups, it is unlikely that laboratory errors are responsible. It may be that the population sample is in fact not homogeneous, or due purely to chance. It must also be considered that individuals of group AB constitute a category which has the highest risk of prenatal incompatibility with their mothers and therefore a higher risk of foetal loss. It may be expected that mother - child incompatibility has a greater effect after a greater number of preceding children. Therefore, deficiency of AB is more likely to occur in populations with a higher rate of births. Nijenhuis[91] observed a systematic deficiency of group AB in rural municipalities in Holland. It appears that this deficiency is proportionately smaller with increasing degree of urbanization, and urbanization goes together with smaller families. Since a higher birth rate and larger family size is found among the Afrikaans-speaking, in comparison with the English-speaking population, it may not be a matter of chance that AB deficiency is observed in the Afrikaans-speaking but not the English-speaking group. In the Coloured population, which has the highest birth rate at the Cape, the rate of foetal loss and perinatal infant mortality is so high from environmental causes that the selective prenatal disadvantage of AB may be obscured.

Subdivision of Donors by Professed Religious Faith

Comparing the alternative methods of subdivision, i.e. by name or by religious faith, the two groups of 'Afrikaans' donors overlap by 72.5%, and the two groups of 'English' donors by 67,7% (Table III). The result of the questionnaire was disappointing, both on the score of low proportion of replies, as well as the disproportionate loss of donors of blood group A among those who replied (Table II). This disproportion weakens the conclusion to a large extent. Nonetheless, subdivision of the donors by religious faith into 'Afrikaans' and 'English' churches reflects a corresponding difference in ABO blood group distribution (Table IV). However, the observation made on this method of subdivision is not considered further in this study.

Subdivision by Language

Schoolchildren professing the Jewish faith were not included. Of the 761 Afrikaans-speaking schoolchildren, 91 (12%) had 'British' family names; while 92 of 467 English-speaking schoolchildren (20%) had names which were passed as Afrikaans family names.

In this much smaller sample (Tables V and VIII), the same general trends in ABO pattern are again observed, although the English-speaking sample has the slightly higher *B* frequency of the two White samples. There is, in addition, a clear difference between Malay and non-Malay Coloureds in the frequency of the *O* and *A* genes.

TABLE V. ABO GROUPS OF SCHOOL CHILDREN IN THE CAPE DIVIDED BY COLOUR, AND SUBDIVIDED — WHITES BY LANGUAGE AND COLOUREDS BY PROFESSED RELIGIOUS FAITH

Ethnic group	Number	Phenotypes %				Genes %			
		O	A	B	AB	O	A	B	D/σ
Afrikaans-speaking	**761**	**362**	**289**	**92**	**18**	**69,62**	**22,85**	**7,53**	**+1,93**
		47,57	**37,98**	**12,09**	**2,37**				
English-speaking	**467**	**212**	**183**	**54**	**18**				
		45,40	**39,19**	**11,56**	**3,85**	**67,43**	**24,54**	**8,03**	**+0,11**
Malay	**353**	**149**	**108**	**78**	**18**				
		42,21	**30,59**	**22,10**	**5,10**	**65,43**	**19,85**	**14,72**	**+0,71**
Non-Malay Coloured	**486**	**172**	**185**	**101**	**28**				
		35,39	**38,07**	**20,78**	**5,76**	**60,43**	**25,19**	**14,38**	**+1,51**

TABLE VI. Rh GENE FREQUENCIES OF POPULATION GROUPS IN THE CAPE DIVIDED AS IN TABLE V

Ethnic group	Number	CDE	CDe	CdE	Cde	cDE	cdE	cDe	cde
Afrikaans-speaking	**641**	**0**	**42,50**	**0**	**0,41**	**13,49**	**1,24**	**5,10**	**37,26**
English-speaking	**474**	**0,25**	**42,30**	**0**	**0,29**	**12,17**	**0**	**8,54**	**36,45**
Malay	**353**	**0,54**	**49,35**	**0**	**2,26**	**11,35**	**0**	**18,84**	**17,66**
Non-Malay Coloured	**486**	**0,49**	**40,07**	**0**	**1,01**	**5,19**	**0,53**	**32,94**	**19,77**

TABLE VII. COMPARISON BETWEEN MALAY AND NON-MALAY COLOURED SAMPLES IN RESPECT OF SELECTED GENE FREQUENCIES (SELECTION DEPENDING ON ANTISERA AVAILABLE FOR POPULATION STUDIES IN CAPE TOWN)

Blood groups	Cape Malay			Non-Malay Coloured		
	Tested	Observed	Genes %	Tested	Observed	Genes %
M	**310**	**90**	**55,32**	**511**	**161**	**58,42**
MN	**310**	**163**		**511**	**275**	
N	**310**	**57**	**44,68**	**511**	**75**	**41,58**
Henshaw	**273**	**13**	**2,41**	**431**	**23**	**2,73**
P	**386**	**229**	**36,23**	**449**	**303**	**42,97**
Kell	**313**	**10**	**1,61**	**524**	**28**	**2,71**
Duffy	**313**	**224**	**46,68**	**525**	**325**	**38,27**
Diego	**106**	**0**	**0,0**	**110**	**3**	**1,37**

TABLE VIII. COMPARISON BETWEEN ABO PATTERNS OF VARIOUSLY DEFINED ETHNIC GROUPS

	Number	A/A+O %	B+AB/ O+A+B +AB %
Afrikaans-speaking:			
by family name	**1 369**	**45,04**	**16,00**
by language	**761**	**44,39**	**14,45**
English-speaking:			
by family name	**1 354**	**48,47**	**15,29**
by language	**467**	**46,33**	**15,42**
Malay:			
by religious faith	**353**	**42,02**	**27,20**
Non-Malay: Coloured:			
self-defined	**486**	**51,82**	**26,54**

The determination of gene frequencies for the other blood group systems have shown, in general, a close agreement between the Afrikaans- and English-language medium groups. The Malay and non-Malay Coloured children differ as clearly in respect of most of the blood group genes which were determined, as they do for the *O* and *A* genes.

DISCUSSION

It is as well to consider at the outset whether blood donors fulfil the criteria for a random sample. Inaccuracy may arise from self-selection, in that the relatively greater usefulness of group O donors for transfusion, particularly as practised in the rural districts in this country, is now generally known. Blood donor populations are not stable, and donors of group O may tend to remain generally more

TABLE IX. COMPARISON OF PHENOTYPE O PER CENT AMONG PROSPECTIVE DONORS WHO HAD NOT GIVEN BLOOD PREVIOUSLY AND THOSE WHO HAD DONE SO OUTSIDE CAPE TOWN

	New donors	Previous donors
Afrikaans names (civilians)	**46,17**	**51,39**
British names (civilians)	**43,65**	**45,74**
Unclassified names (civilians)	**41,09**	**42,35**
Armed Forces and institutions	**44,48**	**49,45**

active. That this is so in Cape Town is shown (Table IX) by the difference in percentage frequency of O between prospective donors who had not previously donated blood anywhere and those who had done so in other centres. The consistent deficiency of A among donors who replied to a questionnaire, sent some time after their enrolment, about their professed religious faith, may likewise indicate more sustained response by O donors. The same argument may apply to some extent, in Cape Town, to donors of group B. There is a much higher incidence of group B among all recipients, who include many Coloured people, than among the donor body, who does not. Therefore group B donors are called more frequently and often more urgently than group A donors.

Married women who may have had antenatal blood tests, medical and paramedical workers and those previously transfused, may be subject to self-selection through prior knowledge of their blood group. For this reason enrolment forms from such persons were excluded from this study. Selections among other types of new donors may occur if active donors of a particular group are urged to bring along blood relatives. This may explain an observation made in the course of the present investigation: to check for consistency, small batches of enrolment forms, taken in chronological order, were subdivided and counted. During one period of 3 months there apparently had been an extraordinarily high rate of enrolment with a considerable excess of new donors of group AB. The proportion of AB to B was 67/75, while that for the remainder of the year was 64/170. It was later established that a considerable amount of publicity had been given at the time to the blood transfusion requirements of two children in need of open-heart surgery. Both children belonged to group A_2B; the occurrence in one child of anti-A_1 agglutinin, active in the temperature range of surgical hypothermia, created a temporary need for A_2B donors. The appeal for donors had carried the explanation that many new donors were required in order to ensure the required number of donors of the relatively rare group A_2B. Among the new donors so recruited a proportion must have had prior knowledge that their blood group was AB. Surprisingly, more than 50% of the group AB new donors, who in this instance did not fulfil the demands of a random sample, were men. (Material for the whole of this 3-month period was excluded from the present report.)

Class distinction and social status may conceivably give rise to a selected donor class. Within the various population groups of Cape Town, social stratification is not of an order which would raise this objection seriously.

During the collection of data for the present study, subdivision within the Afrikaans-speaking and English-speaking groups on the basis of residential area and type of employment, showed that each of the two groups is homogeneous, with consistent minor differences from one another, in respect of blood groups.

With these reservations in mind, it is concluded that the donors in this area were selected on criteria which provided a reasonably random sample. Certainly, donor samples have been accepted elsewhere on a large scale for determination of blood group frequencies. The separation of people in one region into population groups according to their family name, is not new. It was done for the Welsh[92] and for different population groups in Canada.[93] Ethnic separation on the basis of religion and language is a standard anthropological practice. Professed religious faith was the only measure whereby the Jewish Whites could be defined, and the non-Malay and Malay Coloureds could be subdivided. For the Afrikaans-speaking and non-Jewish English-speaking groups language provided, by definition, a third means of subdivision.

Depending on the manner of subdivision of the Gentile White population, the two population groups which result are differently constituted. Approximately 30% of donors with Afrikaans names do not belong to the Dutch Reformed group of churches, and 33% of donors with British names do not profess English or Scottish churches. When subdividing the schoolchildren on the basis of language, the family names which were not classified in the case of the donors, are now taken up into two samples, after excluding the children who were Jewish. This means that Scandinavian, mid-European and Mediterranean family names are taken into account, as well as names which were previously not classified on the grounds of uncertainty. The English-speaking schoolchildren include 19% with 'Afrikaans' family names, and 12% of Afrikaans-speaking children have 'British' names.

Minor but consistent differences between the Afrikaans-speaking and English-speaking groups, whatever the manner of subdivision, were found in respects of the ABO groups; and marked genetic differences between Malays and non-Malays of present-day Cape Town are manifested on the evidence of most blood groups. The blood group distribution of the Afrikaans-speaking and English-speaking groups, as well as the differences between Cape Malay and non-Malay Coloured people, assumes a greater significance when the blood group patterns of their origins are considered.

The populations and their blood group frequencies which have been used for comparison, are given in Tables X - XII. To obtain representative samples, we have selected, wherever possible, the blood group distribution of a single, substantial and apparently random collection of people, such as nationals in the armed forces. Such a wide choice is not available in all instances.

It is clear on historical grounds that neither the indigenous people of Southern Africa nor the immigrants from Western Europe, nor from South-East Asia and India, came to the Cape from single or homogeneous ethnic

TABLE X. COMPARATIVE TABLE OF ABO GENE FREQUENCIES

Population	Number	Genes % O	A	B	D/σ
Dutch soldiers[94]	68 216	67,29	26,60	6,11	+0,12
French airmen[95]	2 780	66,86	26,65	6,49	+1,27
German soldiers[96]	20 000	62,20	28,53	9,57	−1,09
UK airmen[97]	190 177	68,34	25,68	5,98	+0,83
Indonesian soldiers[98]	7 129	62,76	18,44	18,80	+0,89
Bengalese Muslims[99]	1 209	55,78	19,91	24,31	+0,37
South India [100]	341	59,97	16,54	23,49	−1,09
Hottentot[12]	44	50,64	27,65	21,71	−5,04
Madagascar[101]	313	67,26	15,41	17,33	+2,05
Mozambique[102]	4 383	75,61	14,06	10,33	+2,12

units. Published blood group surveys demonstrate differences between the populations within each geographical region. These differences are not always random; for instance, group A increases progressively from north to south in England and Scotland; and group B increases from west to east across Europe. For this reason the choice of a single sample, however representative it may be thought to be, requires some general comment. Most of the information regarding blood group patterns outside Southern Africa, which follows here, is according to the data arranged and discussed by Mourant.[87,88]

Western Europe

There is a very considerable uniformity in blood group distribution of all blood group systems among non-Jewish populations in Western Europe. Compared with the indigenous races of Southern Africa and of South-East Asia and India, there is generally a relatively high frequency of A and a low frequency of B. In Western Europe, there is clearly a tendency for the *B* gene to increase from west to east.

In the rhesus system, degree of uniformity is high. The frequency of 'Rh-negative', dependent on the *cde* chromosome, is consistently and characteristically high; it is second only to *CDe*, with *cDE* relatively much less frequent. The combination *cDe* is characteristically uncommon but variations at a low rate of frequency are found. As regards the other systems, the Duffy gene Fy^a occurs uniformly at an intermediate frequency lower than that of South-East Asia and higher than that of Southern Africa. The Henshaw factor is absent.

In this study ABO frequencies for Western Europe are represented by four large samples, British, Dutch, French and German. Each is presumed to be drawn from a wide area. The 4 rhesus examples are also thought to be representative, except that in the absence of a sample drawn from the whole of the UK, rhesus frequencies from England were chosen. These values appear average among several examples considered. Frequencies of the other genes are illustrated by Dutch values which are approximately average for Western Europe.

TABLE XI. COMPARATIVE TABLE OF SOME Rh GENE FREQUENCIES

Population	Number	CDe	Cde	cDE	cDe	cde
Dutch[103]	995	43,56	1,12	12,46	1,88	40,49
English[104]	927	43,61	0,81	12,80	3,05	37,90
French[105]	1 000	43,18	0,77	12,88	3,62	38,92
German[106]	2 472	43,90	0,59	13,71	2,57	37,80
Javanese[107]	155	84,01	0,0	8,33	6,51	0,0
Bengalese[108]	236	63,30	6,49	7,64	3,87	17,07
South India[100]	341	59,19	2,08	9,38	1,09	27,07
Hottentot[12]	44	17	0	7	76	0
Madagascar[101]	170	32,53	5,67	6,40	43,08	15,32
S.A. Bantu[109]	644	2,56	7,07	4,27	73,95	11,84

TABLE XII. COMPARATIVE TABLE FOR SELECTED GENE FREQUENCIES (SELECTION ON ANTISERA AVAILABLE FOR POPULATION STUDIES IN CAPE TOWN)

Population	M	P	K	Fy^a	He	Di^a
English[110-114]	53,03	51,61	3,70	41,25	0,0	
French[115-117]	54,91	53,43	2,82			
Dutch[118-121]	52,34	55,84	4,37	36,68		
German[122-123]	53,37	49,34				
Indonesian[124]	66,30	22,60	0,25	79,7	0,0	0,0
Southern India[110]	71,84	48,86	0,0	54,39		0,0
Hottentot[10,12]	74		3	15	5	0
S.A. Bantu*[8,9,125]	52,50	63,67	0,30	6,07	3,14	

* Shown in the absence of data for Bantu-speaking Negroes of Mozambique.

South-East Asia and India

The people of South-East Asia and India, mainly illustrated in this study by the Indonesians, and in respect of certain groups by the Javanese, have certain characteristic features of blood group patterns in common, although the people of various tribes and islands may differ considerably in other blood groups respects. High frequencies of *B* are found; in fact, *B* is often in excess of *A*. The *O* gene frequency is very variable.

As in Europe, *CDe* is the commonest Rh chromosome. It occurs in South-East Asia with a higher frequency than anywhere else in the world, excepting New Guinea. The next commonest chromosome among the Sundanese is *cDE;* and *cDe,* while higher than in Western Europe, is still relatively low. Among South-East Asians, the Indonesians lack *cde* entirely and while it does occur in Southern India and Bengal, it is of low frequency. This is something they have in common with the indigenous Southern Africans. Elsewhere in the Rh system they differ markedly in having a very much lower *cDe* and much higher *CDe* frequency.

The *P* gene frequency varies considerably; values among Javanese are lower than in Southern Africa. The Duffy gene, Fy^a, occurs with a frequency at or near 100% among numerous populations in this part of Asia. The Henshaw factor occurs only exceptionally.[91]

The variation in general frequencies of ABO and rhesus genes which are observed between South-East Asia and India are illustrated by three examples. The selection for the Sundanese Islands could be made from a fairly wide choice; in respect of Bengal, as well as Southern India and Ceylon, the choice was limited. Choice in respect of gene frequencies other than ABO and rhesus was very much restricted but is not considered necessarily unrepresentative.

Southern Africa

Unlike Western Europe and like South-East Asia and India, there is not a high degree of uniformity of blood group distribution in the main original Southern African populations—the Bantu, the Bushmen and the Hottentots. Even the Hottentot, with whom this study is mainly concerned, today offers a choice of blood group patterns, since the relative racial purity of some of the few remaining populations which were available for study, is uncertain. In this comparative study, we have used the partially recalculated the ABO and Rh frequencies of 44 Richtersveld Hottentots reported by Singer *et al.*;[15] and for other blood groups we were dependent on the values of 201 Hottentots scattered in South West Africa (Zoutendyk *et al.*).[14] The smaller sample was chosen for ABO and Rh values, regardless of its unsatisfactory size, since doubt has been expressed about the purity of the larger sample.*

From these two samples it is seen that there are very characteristic blood group features which the remaining Hottentot have in common with the other indigenous races; there is a high *B* frequency (considerably in excess of even the other African populations and not much different from the very high Indonesian frequency); while the *A* gene frequency lies well below that of Western Europe and South-East Asia.

In Southern Africa, the strikingly high incidence of the Rh chromosome *cDe* is characteristic. It reaches a particularly high frequency in the Hottentot. The Rh-negative gene *cde* is entirely absent from one sample, and is low in the other. The Hottentot's frequencies of *CDe* and *cDE* are relatively high for an indigenous Southern African people, but are still much lower than those of Western Europe or South-East Asia.

The Henshaw factor is a typically African factor, and reaches a comparatively high frequency in the Hottentot. The gene Fy^a is low among the Hottentot, Bushmen and Bantu; this seems a general Southern African characteristic. Figures for frequency of *P* are not available for the Hottentot, but in the Bantu, which we have to take here as representative of Southern Africa, the frequency is much higher than in people of the Indian mainland and South-East Asia.†

With regard to gene frequencies for other Southern African peoples (not indigenous to the Cape) those of Madagascar and Mozambique are relevant. Values other than those for A, B and O are not available from Mozambique, therefore rhesus and other frequencies of a large sample of South African Bantu-speaking Negroes are shown instead. The Bantu-speaking Negroes of South Africa and Mozambique are genetically so close that we consider this substitution valid for our purpose. In any event, the Mozambique contribution to the total pool of

*Since the completion of this manuscript, the Nama (Hottentot) people in the Keetmanshoop district have been studied. In 1970 Dr Trefor Jenkins of the South African Institute for Medical Research, Johannesburg, surveyed a full range of red blood cell and serum groups, red cell enzyme polymorphisms, haemoglobin types, etc., in a large population sample. These results are part of a report in preparation. More recently we collected blood for HL-A typing of the same population, and used this opportunity to determine those blood groups whose gene frequencies were relevant in the present publication. The ABO and Rh gene frequencies reported by (1) Singer *et al.* from Richtersveld,[15] and other frequencies reported by (2) Zoutendyk *et al.* from South West Africa,[14] as used in the present study, compare with the observations of (3) Grobbelaar among the Korana of the Vaal and the Orange River basins;[13] of (4) the present authors among Nama from Beerseba and Keetmanshoop, and of (5) Jenkins among the Nama from Keetmanshoop and Tses, as follows:

		Gene frequencies												
	Total	O	A	B	CDe	Cde	cDE	cDe	cde	M	P	K	Fy^a	He
(1)	44	51	27	22	17	0	7	76	0					
(2)	203	61	27	19	19	0	6	68	7	74		3	15	5
(3)	377	51	27	22										
(4)	203	53,36	24,75	21,89	18,57	0,0	3,03	78,70	7	70,69	50,38	2,77	37,22	9,84
(5)	153	55,67	27,78	16,55	14,0	0,0	2,77	83,23	0,0	71,24		0,66	29,99	8,99

†Jenkins has reported that the Fy^a frequency is significantly higher in the Bushman than in the Bantu-speaking Negro of South Africa, and in a personal communication confirms the values for *P*, Fy^a and *He* among the Nama. The earlier information that Fy^a is generally low in Southern Africa is thus incorrect; so was our decision to borrow for the Hottentot a frequency for *P* (71,72%) from the Bantu.

Southern African genes at the Cape is of minor importance.

Gene frequencies from Madagascar reflect the fact that the Malagasy are genetically no more than two parts Southern African, the rest being South-East Asian, probably Indonesian.[101] It is an important consideration that the relatively large immigration from Madagascar consisted of a hybrid which already possessed a substantial South-East Asian genetic component.

The question arises whether gene frequencies of the Nama of today, as sampled in the Richtersveld (north-western Cape) and South West Africa, are relevant when the Cape Hottentots of the 17th and 18th centuries are considered. It would be so if relatively pure descendants of the Cape Hottentots were to be found there, or if it were established that a close genetic affinity had existed between the Cape groups and those living so far to the north. For the purpose of the present study we have relied on the latter supposition.

Dutch officials and travellers left useful accounts of the early Cape Hottentots. They were found in loosely organized, nomadic clans from the Cape Peninsula to north of the Orange River. Numerous tribes were described, each with a distinctive Hottentot name. Very early on it was recognized that those at the Cape exhibited minor cultural differences from the Little Namaqua beyond the Olifants River[126,127] and spoke a dialect different from Hottentots (Great Namaqua) north of the Orange River.[128] Over-all, however, there was a high degree of physical homogeneity and frequent contact between neighbouring clans.[129] Early European settlers accepted the Hottentots on their own evidence, as constituting one people,[130] a view which was not gainsaid by either of two early travellers trained in medicine and biological systematics, both of whom observed the Hottentots closely in and beyond the colony.[131,132] Modern anthropological opinion agrees with these earlier views.[133]

The Hottentots who came into early and close contact with the immigrant population were the 'Cape Hottentots': the Goringhaiqua (with a minor subdivision, the Goringhaikona) and the Gorachouqua who frequented the Cape Peninsula; to the north of these were the Kochoqua, as far as Saldanha Bay; beyond them the Chariguriqua or Grigriqua roamed to the Olifants River; and to the east of the Cape settlement were the Chainouqua. Contact with the clans not living in the immediate vicinity of the Cape Peninsula took place by means of bartering visits, either by troops of Hottentots to the settlement or by Dutch expeditions to the clans.

Several other tribes were encountered later as major expeditions were undertaken and outposts were established. To the east were the Hessequa (Caledon-Swellendam), Attaqua (Albertinia-Mossel Bay) and Houteniqua (George); to the north the Great Grigriqua, Little Namaqua and, beyond the Orange River, the Great Namaqua; north-west the Hancumqua and the Chauqua (probably in the present district of Worcester).

The fate of these clans cannot be recounted in detail here; indeed, in point of both time and distance the history of their wanderings is in part obscure. For the earlier period, covering their sojourn in and near the Cape there are contemporary records, official as well as narrative, available in transcript;[23,24,42,134] their arrival near and along the Orange River and among the Great Namaqua of South West Africa at a much later period is mentioned in several travellers' accounts.[135,136] In addition, there are general reviews of Hottentot history based on historical sources and on valuable oral evidence.[137-139]

Contact with the European and Asian immigrants soon led to disintegration of the 'Cape Hottentot' society. Dispossessed of their grazing lands by the colonists within 20 years, a process of dispersal commenced. Mounting pressure led to increased intertribal warfare, disregard for traditional boundaries and disruption of the clans as units. Miscegenation with slaves and colonists produced a bastard class of Hottentot.

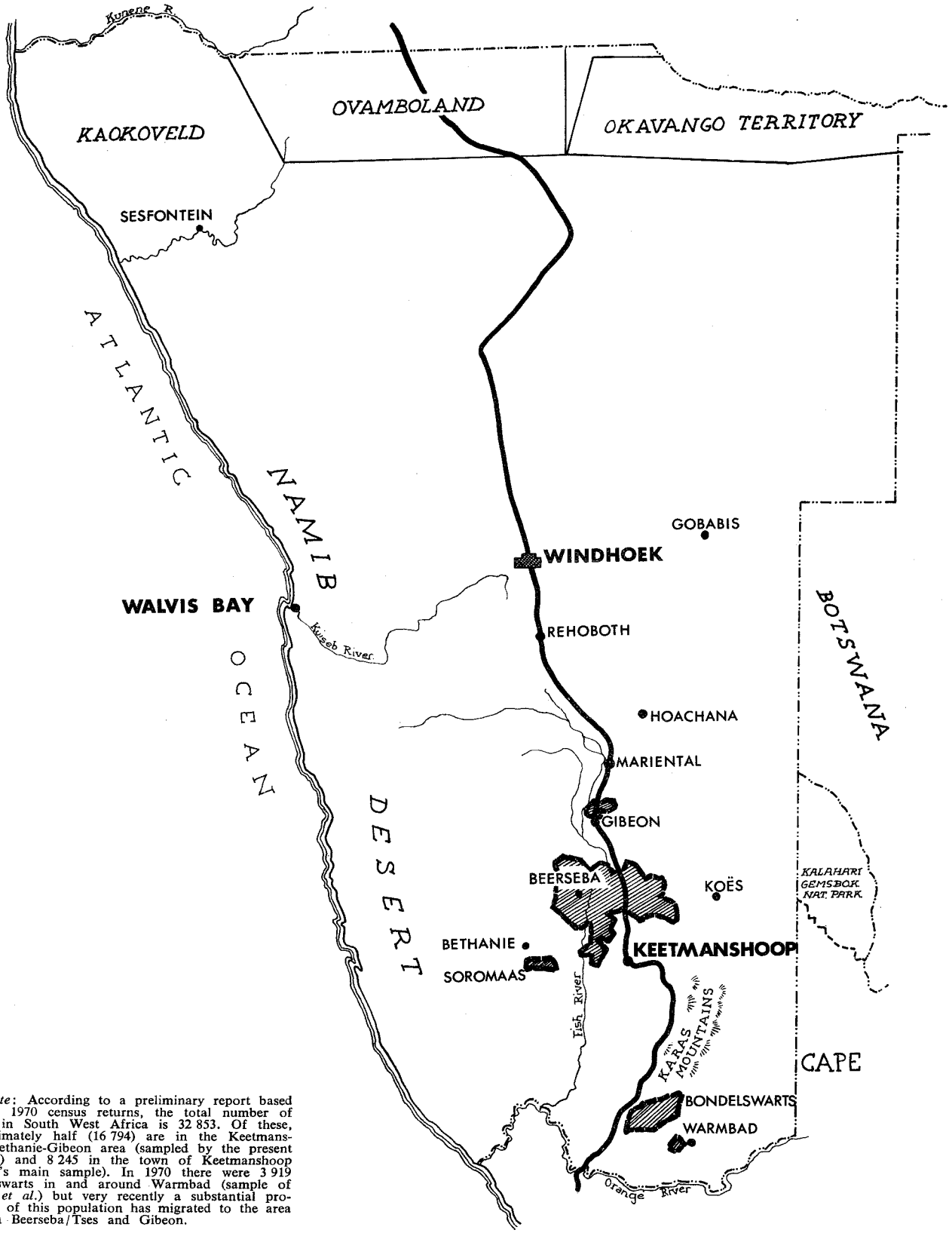
The movement into the interior was in no way organized. Larger or smaller groups left at different times and moved by irregular stages in several directions. The eastward move by the Cape clans, with or through the tribes also giving way there, is poorly documented. By 1778 remains of Cape Hottentots were identified in the region of the Houteniqua, east of George. The move northwards and to the north-west is of greater importance for the purpose of this study.

Those of the Cape Hottentots who went due north remained for variable periods among other clans, such as the Little Namaqua south of the Orange River. In this direction they probably retraced in part the migratory routes whereby Hottentots had originally reached their southern limits. Those migrating north-west into the interior came into repeated and close contact with Bushmen, of whom a number of individuals were incorporated into some of these Hottentot bands, according to tradition.

In 1778 - 9 many different tribes of Hottentots were found along the Orange River from its junction with the Vaal River westwards. Several of these claimed to have arrived from the Cape comparatively recently, after many years of wandering. At this time also the recorded history of the peoples north of the Orange River commences in some detail. It became known that the northernmost Hottentot population consisted mainly of several Great Namaqua tribes in loose relationship to one another, and two tribes claiming independence from them.

At present the original South West African tribes are represented, by their European designation and on historic grounds, as follows: (1) the Rooi Nasie who are found today mainly in the Nama territory near Mariental and Tses; (2) the Swartboois, an offshoot of the former, at Fransfontein in southern Kaokoveld; (3) the Veldskoendraers near Koes; (4) the Fransmanne at Rietfontein in Botswana; and (5) the Groot-Dode, now extinct. The two tribes who were independent are today recognized as (6) the Bondelswarts around Warmbad, and (7) the Topnaars in the Namib to the south of Walvis Bay.

Irregular incursions of Southern Hottentots into the territory of the Bondelswarts and Great Namaqua are known to have occurred before 1791. Wandering bands of robbers were thought to have originated from impoverished and fugitive Cape Hottentots. In the early part of the 19th century more significant incursions took place. An im-



Footnote: According to a preliminary report based on the 1970 census returns, the total number of Nama in South West Africa is 32 853. Of these, approximately half (16 794) are in the Keetmanshoop-Bethanie-Gibeon area (sampled by the present authors) and 8 245 in the town of Keetmanshoop (Jenkin's main sample). In 1970 there were 3 919 Bondelswarts in and around Warmbad (sample of Singer *et al.*) but very recently a substantial proportion of this population has migrated to the area between Beerseba/Tses and Gibeon.

Fig. 2. Map of South West Africa indicating places relevant to the history of the original and migratory Ho!tentot groups. The demarcation of the present homelands of the Nama and Bondelswart people is shown.

poverished tribe of Little Namaqua were given permission by the Great Namaqua to settle in the present Bethanie district. They were followed by several migratory bands which were not Nama, having originated much further south.

In most instances the leaders of these southern bands were not pure Hottentot, claiming a proportion of European blood. Many of the newcomers had adopted the Dutch language, European dress and professed Christianity. Because of their greater knowledge and skills, these tribes became known collectively as the Oorlams. Individually they were known by the names of their leaders. The more important Oorlams incursions were: (1) The Boois people who crossed the Orange River about 1815, wandered around Rehoboth for many years and are said not to have settled into a tribal centre. (2) Amraal's people, who entered in 1815 under a leader who was born in Clanwilliam but came via Worcester; the original Hottentot name of this tribe, Khaua, is thought to be equivalent to the Chauquas listed by Jan van Riebeeck in 1662 to the north-west of the Cape settlement (perhaps near the present Worcester); after wandering in Little Namaqualand, the greater portion (Gei-Khaua) migrated along the Orange River, the Khaua, who entered the country a year later, and after Gobabis. (3) The Hei-Khaua, a smaller portion of the Khaua, who entered the country a year later, and after wandering settled along the Fish River and in the present district of Beerseba. (4) Jonker Afrikaner's people crossed the Orange River permanently in 1822, having previously made sporadic raids as far north as the Kuiseb; they were one of the many roving Korana clans who were found along the Orange and Vaal Rivers as early as 1778. The Korana were mainly constituted by remnants of the Cape Hottentot tribes, the Gorachouqua and Goringhaiqua. (5) The Witboois, who also wandered a great deal before settling finally at Gibeon.

The history of the Nama and Oorlams people in South West Africa during the 19th century is one of incessant upheavals caused by warfare among themselves and against the Herero and, finally, against the Germans. This involved several temporary intertribal alliances and cohesions, which resulted in tribal distinctions disappearing to all intents and purposes.

From the foregoing it may be expected that the Nama today are a genetically homogeneous people possessing a proportion of blood from southern Hottentot tribes. To what extent the northern Nama originally resembled the southern Hottentots cannot fully be established. However, today blood group frequencies do not differ much between the Richtersveld Hottentots, the Korana in the Vaal and Orange River basins and the Nama in South West Africa. More important is the question of non-Hottentot genes among these people, brought from the far south from their own kind or, in South West Africa, received locally from Germans and other Europeans. The Richtersveld Hottentots, the Korana and the Nama all recognize that a great deal of admixture has occurred, but also recognize that among them there are 'pure' families. The more recent blood group studies among the Korana and in the Richtersveld were based on criteria for selection of such 'pure' individuals.

The Cape Population

The ABO blood group distribution indicates a minor genetic difference between the Afrikans-speaking and English-speaking White people of the Cape. Though consistent, the difference is so small that it does not attain statistical significance for the number of observations which were made in this investigation (Tables VIII and XIII).

These two White population groups have in common that both differ significantly from the large samples selected for the Western European nations of their origin in respect of ABO frequencies. The English-speaking donor population's *B* gene frequency of 7,94% (when compared in the form of phenotype B + AB) is significantly higher than that of the UK (Table XIII, *ii* and *iv*). The Afrikaans-speaking donor population's *B* frequency of 8,30% (when compared similarly) exceeds that of the Netherlands by a statistically significant margin; at the same time group *A* (expressed as the ratio of *A* + *O*) is significantly lower (Table XIII, *i* and *iii*).

Among these four Western European nations: Great Britain, the Netherlands, France and Germany the most notable difference in ABO genes is in respect of the frequency of *B*. The gene frequency gradually rises from west to east. It is generally below 7% in the UK and the Netherlands, and commonly over 8% and even 9% in Germany, especially Eastern Germany. The difference in *B* gene frequency between the Afrikaans-speaking people and the nations of Western Europe could only be reduced to statistical insignificance by postulating a predominantly German element of high *B* frequency in the Afrikaans-speaking people. This would permit a *B* frequency in excess of the Dutch frequency of 6% to be employed as the comparative value for Western Europe. However, the proportion of German admixture which would be required before the statistical difference is erased, is not in keeping with historical data. Furthermore, the deficiency of *A* genes could not be explained on this basis; in fact, it is the *O* gene that decreases from west to east.

Accepting as statistically significant the higher *B* frequency of the English-speaking group, and the lower *A* frequency plus the higher *B* frequency of the Afrikaans-speaking population, three possible explanations must be considered for the deviation from the general ABO pattern of Western Europe: random genetic drift, environmental selection affecting the blood groups, and racial admixture.

Any one or combination of these genetic mechanisms could have affected a small stock which, transplanted into an entirely new environment, increased very rapidly in number. The Cape of the 17th to 19th centuries differed socially, climatically and hygienically from Western Europe.

Random genetic drift: The frequency of blood group genes remains stable in a population that breeds freely within itself, if environmental selection has no effect. If the Western European immigrants who populated the Cape were, as a body, not representative of the genetic constitution of their races of origin, the differences would have become established as the population expanded.

TABLE XIII. COMPARATIVE TABLE SHOWING THE DIFFERENCE IN THE FREQUENCY OF O AND A, AND OF B, IN SOME HISTORICALLY RELATED POPULATIONS

	Population	O	A	A/(O+A) %	O+A	B+AB	(B+AB)(+A+B+AB) %
i	Donors with Afrikaans names	632	518	45,04	1 150	219	16,0
ii	Donors with British names	591	556	48,47	1 147	207	15,29
iii	Netherlands	30 892	29 248	48,63	60 140	8 076	11,84
iv	United Kingdom	88 782	79 334	47,19	168 116	22 061	11,60
v	Cape Coloured donors	283	223	44,07	506	203	29,13
vi	Coloured (Malay)	149	108	42,02	257	96	27,20
vii	Coloured (non-Malay)	172	185	51,82	357	129	26,54
viii	Indonesian	2 795	1 907	40,56	4 702	2 427	34,04
ix	Hottentot	12	15	55,56	27	17	38,60

Variation				Chi-squared	P	Chi-squared	P
Between	i	and	ii	2,71	0,05	0,26	0,5
Between	i	and	iii	5,82	0,01	22,37	0,001
Between	ii	and	iv	0,75	0,30	17,84	0,001
Between	vi	and	vii	5,748	0,01	0,041	0,80
Between	vi	and	viii	0,273	0,50	7,038	0,001
Between	vii	and	ix	0,159	0,50	3,122	0,05

Theoretically, the immigrants may have had an unrepresentative blood group pattern because they were too small in total number or a small number were unduly prolific, or because they came predominantly from districts with special genetic characteristics.

Nijenhuis[91] has shown statistically that the population of the Netherlands is not homogeneous as regards the ABO and other blood groups, and came to the general conclusion that the Dutch population is complex and composed of a very large number of isolated components. Fraser-Roberts[90] has likewise shown statistically significant heterogeneity for the north of England. This author poses the question whether local fluctuation, sometimes over quite small areas, can be related to history or geography, or whether it is a matter of chance; and points out that presumably a gene like *B*, of relatively low frequency, is more subject to chance effects producing higher or lower frequency than are genes like *O* and *A*, which are common everywhere.

Small areas of relatively high *B* frequency occur in most countries of Western Europe. Mourant *et al.*[87] have accumulated and tabulated observations for separate regions within those Western European countries which are relevant to this study. In these tables it is seen that the frequency of the *B* gene exceeds 8% in the following instances: England 2 out of 85 (two localized areas in the north), Scotland 2 out of 10 (small samples from isolated islands in both cases), Wales 11 out of 37; Holland 1 out of 105; France 9 out of 101 (of which one instance is among an unspecified population of Paris, and another in a colonial population), and in Germany, particularly East Germany, frequencies of 8 - 10% are common. In these accumulated data, the only Dutch population group to exceed 8% is a collection of 133 Dutch in Indonesia; among them the relatively high frequency of 9,45% is reported.

Selective influence: Mourant[140] has suggested that in related population groups the differences between the ABO frequencies are generally much greater than those in other blood systems. It could be that the ABO genes are particularly susceptible to natural selection, or the opposite may be true, i.e. natural selection operates more efficiently in countering the effect of genetic drift in respect of the other systems.

As regards selective influences which might increase the frequency of group B, a number of conditions are reported to have an unfavourable association with persons of group A. Among those discussed by Race and Sanger[89] are carcinoma of the stomach, death from bronchopneumonia in children, diabetes mellitus and pernicious anaemia. More recently ischaemic heart disease was added. It has also been suggested by Pettenkofer *et al.*[141] that blood group B was maintained and selectively increased in populations which suffered epidemics of plague and smallpox in the past. Regarding smallpox it is claimed on the basis of a postulated group A-like activity of the *Variola* virus, that people with blood group A would be less able to form sufficient antibodies and would therefore be susceptible to fatal infection. Plague, on the other hand, would discriminate against persons of group O, in view of the H (group O) activity of the causative organism, *Pasteurella pestis*. It is to be noted that very severe epidemics, particularly of smallpox, occurred at the Cape. Following an outbreak in 1713, the resident European population decreased from a total of 1 939 (in 1712) to 1 697 (in 1716), in spite of the rapid rate of natural increase at those times.

During further epidemics in 1755, 963 Europeans died and the resident population decreased by 387 to a total of 5 123 between 1754 and 1756; and in 1767 the total deaths among this population group were 179. Pest, possibly plague, occurred in 1663 and 1687; deaths among the European community were recorded during the latter outbreak.[26,142]

Racial intermixture: The question whether the relatively higher frequency of the *B* gene among German immigrants to the Cape could wholly account for the frequency found in the Afrikaans-speaking population has already been considered. The frequencies among donors with Afrikaans names (8,3%) and Afrikaans-speaking schoolchildren (7,53%) are equal to those reported among pure West German populations, whereas the total German contribution to the Cape before 1837 amounts to 35%; and the number of German immigrants from the eastern area of high *B* frequency (8 - 11%) reached the significant proportion of 40% of all German immigrants only after 1807.[5]

All indigenous Southern African people, especially the present-day Hottentots, as well as all South-East Asian and Indian people have a very much higher *B* gene frequency than is found anywhere in Europe. Furthermore, the South-East Asians have a significantly lower *A* gene frequency. The increased frequency of *B* genes in the two White population samples could be accounted for by South-East Asian or Southern African genes, either alone or together. A significant proportion of South-East Asian genes in the Afrikaans-speaking sample could explain the deviation from the frequency of *A* in present-day Western Europe.

In considering the possible influence of African, Asian and European gene mixing on blood group patterns of the White population of the Cape one must consider the possibility that a reservoir of these genes is available for study in the Cape Coloured people of today.

The Coloured Population of the Cape

The Dutch and French as colonists, and later the earlier British settlers, accepted marriage between races. However, many of the surplus males in the European colony did not contract marriage bonds at the Cape. Substantial numbers of males passed through on visits lasting days, weeks or months. Irregular relationships, particularly of a temporary nature, would have determined that transfer of genes involving Europeans would be largely towards the non-European population. Children born out of wedlock are generally taken into the mother's population. As regards slave women, children of mixed origin would also have reverted to the mother's status, in terms of the Roman Law practised at the Cape.[143] Official provision was made to exempt children of European fathers born to slaves of the Dutch East India Company from this general law. This did not apply generally to slaves in private ownership.[54,144] It follows that if genetic admixture between the European immigrants and non-European people had occurred to any measurable extent, blood group evidence for this may be found more conclusively in the present Cape Coloured people.

Possible evidence of Western European admixture cannot be weighed without considering at the same time the blood group genetic contributions of the Southern African and Asian peoples to the Cape Coloured population. If the people from Mozambique (who did not make an important quantitive contribution when estimated on historical records) are excepted, the over-all ABO gene frequencies of Southern African and Asian populations do not differ much from one another (Table X). This is an important consideration, because the greater the difference in frequencies of a gene in two populations, the more useful that gene is in assessing their admixture. On the other hand, where two populations have similar frequencies for a given gene, the extent of their simultaneous admixture with a third population differing substantially from them in respect of that gene frequency can still be judged approximately on the frequency in the three-part hybrid population.

The *O* and *A* frequencies of the Cape Coloured lie within the wide range of values for Asia, Southern Africa and Western Europe and cannot provide evidence of their genetic composition; but the frequency of the *B* gene in the Cape Coloured donor population taken as a whole, is so low (15,74%) as to be outside the main Southern African - Asian range (17,33 - 24,31%). This may well indicate a Western European genetic contribution of low *B* frequency to the hybrid.

In pursuing the analysis of ABO data, the subdivision of the Cape Coloured schoolchildren into Malay and non-Malay is rewarding. Table XIII brings together ABO ratios based on blood group frequencies of various population groups for comparison. Values from the Netherlands, the UK, Indonesia and the Hottentots were selected as broadly representative of the races of origin. The salient points that arise are: The Cape Malay and non-Malay Coloureds are alike in having *B* frequencies (Table XIII: *vi and vii*) below those of Asia (*vi* and *viii*) and Southern Africa (*vii* and *ix*); in respect of 2 genes (*O* and *A*) the Cape Malay is closer to the Asian sample (*vi* and *viii*) than to the non-Malay Cape Coloured (*vi* and *vii*), while the non-Malay is closer to the Southern African (Hottentot) sample (*vii* to *ix*) than to the Cape Malay. This suggests that the Malay as well as the non-Malay sections of the Cape Coloured people have blood group evidence of Western European admixture, and that the difference between the two Coloured populations is a reflection of genetically distinguishable Asian and Southern African components.

The validity of these conclusions was tested in terms of additional blood group systems. In general, the ABO system is less helpful than other blood group systems in analysing the composition of populations. The ABO gene frequencies show less evidence of homogeneity in established populations[140] and a lesser tendency towards equilibrium at the expected level after hybridization.[91] Furthermore, the difference between the three races of origin—Western European, Asian and Southern African—with which this study is concerned, is much more marked in respect of gene frequencies in other blood group systems.

The gene frequencies of 5 other systems (M and Henshaw are part of one system) suggest even more strongly that a 3-part hybridization of wide genetic mixture is responsible for the Cape Coloured blood group pattern. The 4

TABLE XIV. GENE FREQUENCIES IN CAPE COLOURED, MALAY AND NON-MALAY, COMPARED WITH ONE ANOTHER AND WITH HOTTENTOT AND INDONESIAN FREQUENCIES

Genes	Hottentot	Non-Malay Coloured	Malay	Indonesian
O	51	60,43	65,42	62,76
A	27	25,20	19,86	18,44
B	22	14,37	14,72	18,80
CDe	17	40,06	50,34	84,01
cDE	7	5,19	11,35	8,33
cDe	76	32,94	18,84	6,51
cde	0	19,77	17,66	0
Cde	0	1,01	2,26	0
M	74	58,42	55,32	66,30
P	63,67*	42,97	36,23	22,60
K	3	2,71	1,61	0,0
Fy^a	15	38,27	46,68	79,7
He	5	2,73	2,41	0,0
Di^a	0	1,4	0	0,0

* South African Bantu.

common rhesus genes *CDe, cDE, cDe* and *cde,* as well as nearly every one of the gene frequencies in all the systems studied, i.e. MN and Henshaw, Kell, Duffy, and Diego, differ in the Cape Malay and the non-Malay Coloured. With few exceptions (*cde, He* and Di^a) these differences appear to be consistently related to similar but wider differences between frequencies of the same genes in a South-East Asian and a Southern African population (Table XIV).

The occurrence of the Diego factor in 3 non-Malay Coloured individuals deserves passing comment. This blood group has been demonstrated in Asiatic or Mongoloid peoples;[145] it is absent from Caucasoids, pure Negroes[146] and South-East Asian populations.[147] It occurs relatively frequently among the Chinese and Japanese. It is of note that Chinese were among the earliest immigrant settlers at the Cape, married slave women and were commonly polygamous.[148]

Table XIV is an over-simplified presentation of a complex situation as regards the Southern African and Indonesian origins of the Cape populations. Indonesian and Javanese frequencies may indicate adequately the main inflow of South-East Asian genes, but it is not representative of the total Asian component which includes contributions from genetically divergent peoples such as those of the Indian mainland. Likewise, the Hottentot represents the indigenous Southern African element, but does now allow for the differing gene pattern of the Madagascar people, who were not indigenous but also came from Southern Africa. In particular, the occurrence of the genes *cde* and *Cde* in the Cape Malay as well as in the non-Malay Coloureds is an absolute indication of an Rh genetic component additional to the Hottentot and Javanese.

The frequency of *cde* in the other Asian samples and among the part-Indonesian hybrids of Madagascar is not high compared with the frequency which it attained in the Cape Coloured peoples. The Cape hybrid frequencies (17,66 - 19,77%) are exceeded among those Asian and Southern African samples used in this comparative study only in South India (27,07%). It would have required an overwhelming proportion of Southern Indian admixture to the general South-East Asian, Bengalese, indigenous Southern African and Malagasy gene pool to reach the observed Cape frequencies. It may rather be suggested that the frequency of *cde* in both the non-Malay and in the Malay (and also the frequency of *cDE* in the Malay) postulates a genetic increment in these two population groups which is almost of necessity additional to the sum of any likely proportion of Asian - Southern African genetic combination.

The *M* gene frequencies of the Malay (55,32%) and the non-Malay (58,52%) are lower than those generally observed in India, South-East Asia or among the Hottentot (66,30 - 74%). It lies between these frequencies and those of Western Europe (52,34 - 54,91%) and the Bantu-speaking Negro (52,50%). Taken together the evidence of three independent blood group systems (frequencies of *B, cde* and *M)* in both sections of the Cape Coloured population points towards a significant Western European genetic participation in the hybrids. An attempt was made to consider this conclusion quantitatively.

Bernstein's formula, as used by Glass and Li[149] among others,[101,150] is applied in order to calculate the amount of racial admixture which has occurred in a hybrid population, if the frequency of any particular gene allele is known in the hybrid and two base populations.* This formula is not intended for a complex process of hybridization such as occurred at the Cape, where we have three main base populations of which at least two were composed of peoples who are genetically divergent (Asian = Sundanese, Southern Indian and Bengali; Southern African = Hottentot, Malagasy and Mozambican), while the hybrid consists of two genetically distinguishable components, Malay and non-Malay. Nonetheless, it was considered worthwhile to select representative frequencies in order to calculate approximately the genetic constitution of the Coloured and the White populations at the Cape. This information, admittedly only approximate, was required for our purpose of establishing on a rational basis a diagnostic laboratory service and a genetic counselling service in respect of inherited blood diseases.

For our purpose we used as two base populations: Western European (values from the Dutch were taken as representative) and Southern African (represented by Hottentot frequencies), and as a hybrid the Cape Coloured population (Malay and non-Malay frequencies in equal proportion); and in this manner the frequencies of 4 common Rh genes *CDe, cDE, cDe* and *cde* were employed in turn for calculating Southern African X values.

Using the frequencies in this fashion, the percentage contribution from the Southern African pattern of Rh genes to the Cape Coloured emerged as: *CDe* = 4%, *cDE* = 77%, *cDe* = 32% and *cde* = 54%.

These serious discrepancies between the results for the

*The formula may be expressed as follows: Q and q are the frequencies for a gene allele in the participating base populations; and qx is that in the hybrid population.

$$\% \text{ q component} = \frac{q^x - Q}{q - Q} \times 100$$

different genes were resolved as follows: the gene *cDe* is highly characteristic for the Southern African base population and may reflect more accurately the correct gene inflow (32%) from this source; deviations from 32% in respect of *cDE* and *cde* (in excess) and *CDe* (grossly deficient) indicate a concurrent gene inflow into the Cape Coloured from a third base population with a low (or absent) *cde*, a very high *CDe* frequency and *cDe* lower than the Western Europeans. The Asian Rh gene pattern fits this requirement exactly.

The calculation did not take into account any Asian contribution to the Cape Coloured hybrid. To allow this, the Javanese gene frequencies were selected as most representative. When the Javanese frequency for *cDe* is substituted for Western European, the proportion of Southern African in the hybrid is 30%. Therefore, whether the Dutch or the Javanese frequency or any combination of these two, is used, the Southern African (Hottentot) element in our combined Cape Coloured gene pool is in the range 30 - 32%.

Since *cde* is absent from the Indonesian as well as the Hottentot samples, any calculated Western European contribution to the Cape Coloured gene pool based on the frequency of this gene amounted to 46%.

Accepting these calculated percentages, a hypothetical hybrid population was constructed with the following proportion of the Rh genes: Dutch 46%, Hottentot 32% and Javanese 22%. This produced a hypothetical 3-part hybrid population which is, in respect of the Rh gene pattern, close to the observed Cape Coloured (combined Malay and non-Malay) frequencies. To test further the suggested proportions of a 3-part genetic contribution to the Cape Coloured blood group pattern, Dutch, Hottentot and Indonesian frequencies of the ABO and other systems were calculated in the same proportions. The pattern of the hypothetical race again fitted the observed pattern of the combined Cape Coloured genes remarkably well (Table XV).

The simplified concept of the genetic constitution of the Cape Coloured patient population was useful in designing laboratory programmes for investigation of clinical disorders possibly due to genetically determined blood abnormalities, e.g. the diagnosis of haemolytic disease of the newborn, and in investigations of haemolytic anaemias of pregnancy.[1,3] However, a simplified calculation was expected to produce an answer of limited scientific value. Therefore, it was not intended for publication. Regrettably, however, a report based on an over-simple calculation (which omitted Asian genes altogether) did appear in print[21] in spite of obvious limitations. It formed the basis for a conclusion that the Cape Coloured population are genetically more closely related to the Whites than to the Negro. We now feel that these gene frequency calculations should be presented more completely in the light of the reservations which are due.

The evident weakness in the foregoing calculations is illustrated by the gene *cde*: 2 of the samples selected to represent base populations (Hottentot and Javanese) do not possess this gene, but not all the Asian and Southern African peoples who came to the Cape lacked *cde* completely, therefore the X value calculated to represent the Western European contribution (46%) is excessive. To correct such inaccuracy, a much wider genetic contribution, in which all the main immigrant populations were represented, would have to be taken into account. This was achieved by combining gene frequencies for each of the 3 main regions, Asia, Southern Africa and Western Europe. Values for these calculations were obtained from Tables X - XII.

TABLE XV. COMPARATIVE GENE FREQUENCIES OF THE OBSERVED CAPE COLOURED POPULATION (AVERAGE OF MALAY AND NON-MALAY SCHOOLCHILDREN AND FACTORY PERSONNEL) AND TWO HYPOTHETICAL HYBRID POPULATIONS

Genes	Hypothetical I Dutch 46% Hottentot 32% Indonesian 22%	Cape Coloured	Hypothetical II Western European 34% Southern African 36% Asian 30%
O	61	63	62
A	25	22	22
B	14	15	16
CDe	44	45	45
cDE	10	8	9
cDe	27	26	24
cde	19	19	19
Cde	1	1	2
M	62	57	65
He	2	3	2
P	51	40	52
K	3	2	2
Fy^a	39	42	38

The frequencies of Indonesia, Southern India and Ceylon, and Bengal were combined in a ratio of 2:1:1 to constitute Asian frequencies: and the Hottentot, Madagascar and Mozambique (or South African Bantu substituted for the latter) frequencies in the ratio of 10:10:1 for Southern Africa. Western European frequencies were combined in equal proportions of Dutch, English, French and German. These proportions were determined by our own impressions of the relative importance of the different peoples in the social history of the Cape. The calculated values for the 3 regions are shown in Table XVI.

At this point it may be stated that the choice of representative population samples from which to obtain gene frequencies, having been made initially, was not changed in a single instance after calculations had commenced. Likewise, having decided on the ratios in which peoples with divergent gene frequency patterns were to be combined, these were not altered subsequently. Perhaps it would have been possible to manipulate the choice of frequencies or the manner of combining them to obtain preconceived answers from the calculations. Since we do not know to what extent this might be possible, we think it is as well to state that Q and q values were not changed once an X value had been calculated from them.

Genes which have widely different frequencies in two base populations are more likely to give accurate results by Bernstein's formula. For small differences of gene frequency between populations, the standard error of the

TABLE XVI. REPRESENTATIVE GENE FREQUENCY DISTRIBUTIONS OBTAINED BY CALCULATION FROM OBSERVED POPULATION VALUES IN THREE GEOGRAPHICAL REGIONS WHICH CONTRIBUTED TO THE CAPE POPULATION

	Asia		Western Europe		Southern Africa	
	Indonesian	= 2	British	= 1	Hottentot	= 10
	Bengalese	= 1	Dutch	= 1	Malagasy	= 10
	Indian	= 1	French	= 1	Mozambican	= 1
Genes			German	= 1		
O	60		66		60	
A	18		27		21	
B	21		7		19	
CDe	73		44		24	
Cde	2		1		3	
cDE	8		13		7	
cDe	5		3		60	
cde	11		39		8	
M	69		53		72	
P	37		53		64	
K	0		4		3	
Fy^a	67		39		14	
He	0		0		5	

difference, unless the observations are made on enormous samples, may equal or even exceed the value of the difference itself. In this respect, our own observations are limited. To meet this requirement we employed gene frequencies for *CDe, cDe, cde* and Fy^a.

By substituting the combined regional frequencies of Western Europe, Southern Africa and Asia for the Dutch, Hottentot and Indonesian values in the calculation dealing with the Cape Coloured population as a single mixed population, the X values (genetic component per cent) were Southern African (q)—Asian (Q): *cDe* X 38%; Southern African (q)—Western European (Q): *cDe* X 40%; Western European (q)—Southern African (Q): *cde* X 35%; Western European (q)—Asian (Q): *cde* X 29%; Asian (q)—Southern African (Q): *CDe* X 43%; Fy^a X 48%.

Taking together the average of the 2 X values obtained for each region, the total of the three regional genetic components amounts to 116%. This may be adjusted as follows: the Asian component should be much reduced, because a concurrent Western European gene inflow would assist in increasing the Southern African frequency of *CDe* and Fy^a (the Western European values in this situation being *CDe* X 105% and Fy^a X 115%). The Western European (*cde* X) and Southern African (*cDe* X) components, calculated on the basis of gene frequencies which are characteristically high in relation to almost equally low frequencies in the other two base populations, may be accepted as approximately correct.

A second hypothetical hybrid population was constructed with the following proportions: Western European 34%, Southern African 36%, Asian 30% (Table XV). There was excellent agreement with the combined observed frequencies of the Cape Coloured population, except for the hypothetical frequency of *P* (51%) which is in excess of the observed (40%). It was noted however that in the absence of data for the Hottentot, the relatively high frequency for *P* among the Bantu, amounting to 63,67%, was taken to represent the Southern African genetic weight in calculation. We think that the *P* gene frequency of the Hottentot, when it has been measured, may well fall at or just below 50%. Alternatively, the frequency of *P* in the combined Cape Coloured population provides support for Nijenhuis' argument in favour of the operation of natural selection.[91] In his study on the population of Curaçao, the mixed groups also have a more European character, judged by the distribution of the *P* factor, than might be expected from calculations for European admixture based on other frequencies.*

We conclude then that the Cape Coloured population, in Cape Town and taken together (but excluding pure Indians, whether Muslim or Hindu), are constituted by approximately equal proportions of European, Asian and Southern African genes. If these calculations are valid, it should be possible to demonstrate that two or three racial components are present in differing proportion in the Malay and non-Malay Coloured samples.

Regarding the Cape Malay in the first instance as an Asian - Southern African hybrid, Fy^a X and *CDe* X both indicate 57% Asian genes. However, it has to be taken into account that with a concurrent Western European inflow of Fy^a and *CDe* genes, the Asian and Western European influences would have operated in the same direction. Therefore 57% may be an unrealistically high figure for an Asian contribution. In terms of *cDe* X value the Southern African contribution in the same situation is 25%. This may be accepted as realistic. Compared with the Southern African value, *cDe* frequencies are so much lower in both the other base populations that neither would interfere unduly with the other in a process of attaining equilibrium. According to *cde* frequencies, the Western European proportion in the Malay would be 24% if hybridization had occurred only with Asians. Since there was a Southern African *cde* genetic influence in the same direction as the Asian, the Western European contribution very likely would have been greater than 24%.

Using this as a guide, the proportions of these gene frequencies were adjusted by calculation until a good fit was obtained with the observed Malay frequencies. A hypothetical hybrid consisting of 42% Asian, 33% Western European and 25% Southern African comes close to matching the Cape Malay in many respects. By similar calculations a hypothetical hybrid was found to match the non-Malay Cape Coloured in many respects; this consists of 46% Southern African, 32% Western European and 22% Asian genes (Table XVII).

The possible objections to these calculations have already been stated. Since it is admitted that the values for the base population are approximations, in certain instances based on an arbitrary choice of population sample and in other instances on arbitrary ratios of divergent peoples, it would be drawing too fine a point if serious consideration were given to the lack of really good fit between the observed frequencies and those of our hypothetical populations. It is of interest, nonetheless, to point

*The *P* frequency is 50,38% in our recent Nama sample.

TABLE XVII. GENE FREQUENCIES OF THE CAPE MALAY AND NON-MALAY COLOURED IN COMPARISON WITH CALCULATED FREQUENCIES OF TWO HYPOTHETICAL HYBRID POPULATIONS

Genes	Hypothetical I: Southern African % 46, W. European 32, Asian 22	Non-Malay Coloured	Cape Malay	Hypothetical II: Southern African % 25, W. European 33, Asian 42
O	61	60,43	65,42	62
A	22	25,20	19,86	22
B	16	14,37	14,72	16
CDe	41	40,06	50,34	51
cDE	9	5,19	11,35	9
cDe	30	32,94	18,84	18
cde	18	19,77	17,66	19
M	63	58,42	55,32	64
P	55	42,97	36,23	49
K	3	2,71	1,61	2
Fy[a]	36	38,27	46,68	45
He	2	2,73	2,41	1

out that the gene frequencies which show less satisfactory correspondence are those for the ABO, M, P and Henshaw groups; in a study of mixed populations (Dutch and West African Negro) in Curaçao, Nijenhuis found that the ABO and P systems were not what might have been expected from the calculated composition of the hybrids; he goes on to say that the variability of M and Henshaw (which are not transmitted independently), may be due to the pressure of selection being very strong on the genes of this blood group system.[91,351]

If hybridization occurs on a sufficiently large scale, or if the process is continuous, the social attitude of the original base populations towards the mixed population may demarcate a new people. Propagation of the new population through inbreeding may commence; at the same time further hybridization may occur between one or more of the original populations and the hybrid population. Social custom may determine that the transfer of genes will continue to be predominantly into the new population, but hybrid individuals may emerge who are taken up into original stock. New genes may then become incorporated into one or both of the original population groups.

The White Population of the Cape

If the comparatively high frequency of the *B* gene in the Afrikaans-speaking and English-speaking population may be related to the characteristically high *B* frequency of the Southern African and the Dutch East Indian, certain long-standing observations on the Rh genes of the White population of South Africa should be viewed in this context. Shapiro,[19] without providing values, refers to the effects of miscenegation between Whites and Negroes on the Rh gene distribution in South Africa; his diagram shows not only that the characteristically high Southern African *cDe* has a much reduced frequency in a group of South African Coloureds (Kimberley), but that there is a correspondingly slight increase of this gene frequency in the South African Whites over the French, English and Dutch frequencies. The data for the Cape confirm this, and show a statistically significant difference in respect of rhesus gene frequencies between the Afrikaans-speaking and English-speaking groups on the one hand, and the people of Western Europe on the other.

From the Rh gene frequencies in Tables VI and XI, expected genotypes were calculated for each population sample. The genotypes were in turn employed as observed data for the purpose of *chi*-square analysis for difference in the Rh blood group pattern between the ethnic groups. In Table XVIII (*i* and *ii*, *i* and *iii*, *ii* and *iv*) it is seen that the difference between the Afrikaans-speaking and English-speaking schoolchildren does not approach statistical significance, while both these samples are significantly different from the calculated patterns for Western Europe (the Afrikaans-speaking group much more so). This confirms the conclusions based on the earlier analysis of ABO frequencies. As would be expected from the earlier calculations, the difference between the subdivided Malay and non-Malay Coloured is also statistically significant; the Cape Malay differs from the Asian as represented by Javanese frequencies (*vi* to *vii*) and the non-Malay Coloured from the Hottentot (*vii* and *ix*). Admittedly, the size of the Hottentot sample, a total of 44 observations only, reduces the genotypes in most instances to such a low number, or even zero, as to render statistical comparison less than satisfactory. However, even under these circumstances the high P values are considered to have significance.*

Since the frequency of *cDe* in the White population groups of the Cape is intermediate between that of Southern Africa on the one hand and Western Europe on the other, the question arises whether the observation is suitable for analysis by Bernstein's formula. The calculation would be subject to the same reservations as those stated for the Cape Coloured data. There are again three base populations to be taken into account: Western European, Asian and Southern African, not one of these being homogeneous. As previously, this complexity may be resolved partly by using artificial gene frequency pools obtained by preliminary calculation (Table XVI).

For the purpose of Bernstein's calculation, the frequency of *cDe* has particular merit. The Southern African frequency has a wide difference from the Western European; at the same time the Asian gene frequency is so close to the latter, that any uptake, concurrently with the Southern African inflow, would not grossly disturb the process of equilibration between the Southern African and Western European frequencies. Calculating the combined Southern African *cDe* frequency (q = 60%) and the combined

*Our recent Nama sample of 203 individuals in a similar calculation gives equivalent results.

TABLE XVIII. DIFFERENCE IN THE FREQUENCIES OF THE Rh PATTERNS IN SOME POPULATIONS*

Population	CDe/ CDe	CDe/ cDE	CDe/ cDe	CDe/ cde	cDE/ cDE	cDE/ cDe	cDE/ cde	cDe/ cDe	cDe/ cde	cde/ cde	The rest
i **Afrikaans-speaking schoolchildren**	116	73	28	203	12	9	64	2	25	89	20
ii **English-speaking schoolchildren**	85	49	34	146	7	10	42	4	30	63	4
iii **Dutch**	192	109	16	354	15	5	100	1	15	163	25
iv **English**	176	103	25	306	15	7	90	1	22	133	49
v **Malay schoolchildren and factory workers**	89	40	67	63	5	15	14	13	23	11	13
vi **Non-Malay schoolchildren and factory workers**	78	20	128	77	1	17	10	53	63	19	20
vii **Indonesian**	172	44	20	0	3	2	0	1	0	0	5
viii **Hottentot**	1	1	11	0	0	5	0	26	0	0	0

Variation between	i and ii	i and iii	ii and iv	v and vi	v and vii	vi and viii
	17,57	29,355	55,37	58,18	165,29	16,07
	0,10>P>0,05	0,005>P>0,001	0,005>P>0,001	0,005>P>0,001	0,005>P>0,001	0,005>P>0,001
	X^2 [10]				X^2 [3]	
	P				P	

* The Rh genotypes which were used as observed data in X^2 analysis, were recalculated from gene frequencies in Tables VI and XI.

TABLE XIX. DIFFERENCE BETWEEN TWO SAMPLES OF ENGLISH-SPEAKING SCHOOLCHILDREN EXPRESSED AS PERCENTAGES OF cDe AND cde GENES; A PROPORTION OF GENE ADMIXTURE CALCULATED IN TERMS OF WESTERN EUROPEAN AND SOUTHERN AFRICAN FREQUENCIES; AND THE PROPORTION OF AFRIKAANS NAMES IN SAMPLE

		cDe		cde		
	Total	Gene frequency	X value for admixture	Gene frequency	X value for admixture	Pupils with Afrikaans names
One school	122	13,52	18	32,65	20 - 23	32,8
Remainder	345	6,91	7	37,68	4 - 5	14,8

Western European frequency (Q = 3%) with the frequencies of the Afrikaans-speaking sample (5,10%) and the English-speaking sample (8,54%) in turn, the X value indicating the proportion of Southern African genes is 3,7% and 9,7% respectively.

The Asians, as a base population responsible for an inflow of genes, do not offer as good a choice of frequencies for calculations based on Rh genes. The low frequency of *cde* (11%) relative to a moderately high Western European frequency (39%) would determine its choice. In this instance, however, the concurrent inflow from the third base population (Southern African), who also have a low *cde* frequency (9%), would combine with the Asian effect of lowering the *cde* frequency of the Western European. Although an acceptable value for the combined effect may be calculated, the proportion of either contribution will not appear from this single calculation. It may be possible, however, to view the proportion separately. By taking Western European values for the first base population (Q) and, as the second base population Southern African (q) and Asian (q) values successively in relation to the *cde* frequencies of the Afrikaans-speaking schoolchildren and the English-speaking schoolchildren, the gene intake from the races of low *cde* frequency amounts to 5,5 - 6,1% in the Afrikaans and 8,2 - 9,0% in the English-speaking sample.

In the English-speaking population, the calculation using an Asian *cde* frequency indicates a gene intake of 9,0%, which is similar to that indicated by a Southern African *cDe* X (9,8%) and a Southern African *cde* X (8,2%). Therefore both observations may be ascribed to a Southern African genetic effect alone. If this is so, the value derived from *cDe* has this merit that the calculation is based on a much wider difference in frequencies between the two base populations. In calculations based on the observed gene frequencies of the Afrikaans-speaking group and of the combined Asian samples, *cde* indicates a bigger (6,1%)

TABLE XX. X VALUES CALCULATED MATHEMATICALLY FROM ABO GENE FREQUENCIES TO REPRESENT THE PERCENTAGE OF ASIAN AND SOUTHERN AFRICAN GENES IN A WHITE DONOR POPULATION

	Asian			Southern African		
	O X	A X	B X	O X	A X	B X
Afrikaans names	−21	28	9	−21	42	11
English names	7	6	7	7	9	8

gene intake than does a Southern African *cDe* X (3,7%). The difference, amounting to about 2,4% may represent a South-East Asian genetic contribution over and above that from a Southern African origin.

We have referred previously to Nijenhuis' observation that in his material the calculated values for X based on ABO frequencies do not correspond to the average X values based on other gene frequencies; and the author suggested that ABO gene frequencies should not be taken into account in calculating total X values since ABO X values in mixed populations may have been unduly affected by natural selection and genetic drift.[91]

We were prompted to include the ABO frequencies of the two White donor populations in the analysis for two reasons: the donor samples, restricted to ABO frequencies, were much larger than those consisting of schoolchildren; and the donors were a truly random and homogeneous sample, whereas the sample of the English-speaking schoolchildren appeared not to be so (Table XIX). The results of this analysis of White blood donors are shown in Table XX.

Among White donors with English names, the *O* X, *A* X and *B* X values for Asian and Southern African genetic components (6 - 9%) are reasonably consistent and correspond with, but are lower than, the *cDe* X value (9,8%) and the Southern African *cde* X value (9,0%). Furthermore, the component calculated on the basis of Southern African *O, A* and *B* gene frequencies (average 8%) is again slightly larger. The average of 9 X values is 8% (Table XXI). Only one of these genes is useful in differentiating between a Southern African or Asian component in this situation. The characteristically Southern African gene *cDe* has an X value of 9,8%. It is thus superfluous to postulate an Asian increment to the total.

Among White donors with Afrikaans names the *O* X, *A* X and *B* X values are not consistent. The average of the 9 X values is 7%. The typically Southern African *cDe* X value is 3,8%. An additional Asian component of low *cde* and high *B* frequency seems indicated. Asian *B* X and Southern African *B* X values are 6 and 11%; and the former is in reasonably good agreement with the corresponding *cde* X values of 6,1 and 5,5%, i.e. about 6% of Asian genes will explain all of the increase in *B* genes and all the loss of *cde* genes.

It is, however, not possible to ignore the fact that the most positive X values in the Afrikaans donor population are Southern African *A* X (42%) and Asian *A* X (28%). If changes in gene frequency were due solely to gene mixing, these *A* X values would imply loss of *A* genes among donors with Afrikaans names due to a major Southern African or substantial Asian genetic contribution of low *A* gene frequency.

TABLE XXI. PERCENTAGE OF SOUTHERN AFRICAN AND ASIAN GENES IN SAMPLES FROM AFRIKAANS-SPEAKING AND ENGLISH-SPEAKING WHITE SCHOOLS

	Afrikaans	English
Southern African — Western European		
cDe X	3,8	9,8
cde X	5,5	9,0
Average ABO X	11	8
Asian — Western European		
cde X	6,1	9,0
Average ABO X	5	7
Average of 9 genes	7	8

Average ABO = average of A X, B X and O X.

The discrepancy between *A* X values and other X values among White donors with Afrikaans names may be due to disproportionate loss of *A* genes as a result of natural selection or genetic drift. Haemolytic disease of the newborn may be cited as a possible mechanism. It is said that in general, balanced genetic polymorphism results from the advantage which the heterozygote phenotype has over the homozygotes; however, haemolytic disease of the newborn is an unusual condition in that it eliminates heterozygotes only.[152]

Because the association between this disorder and maternal - foetal incompatibility for the rhesus factor D-negative and D-positive is comparatively common in Europe and elsewhere, it has been suggested that the death of a substantial number of heterozygous children (D-positive/D-negative, or D/(d) phenotype) should lead to a severe loss of the gene allele with the lower frequency, i.e. D-negative (or d).[153] To explain why a high percentage of D-negative genes (mainly in the form of *cde*) persists in Europe, it has been suggested that affected families compensate for the loss of one or more heterozygote children by a higher rate of conception and thus producing several D-negative (d/d) children. This argument may be applied to ABO genes in situations where haemolytic disease of the newborn due to maternal - foetal O - A incompatibility is comparatively common.[154]

Among our Coloured and Bantu patients in Cape Town, severe haemolytic disease of the newborn is about as often due to O - A plus O - B incompatibility as to D-negative - D-positive incompatibility. It is also comparatively common elsewhere among populations who live in inferior social circumstances, and it has been suggested that poor hygiene exposes the population to micro-organisms which induce a pathogenic state of anti-A and anti-B immunity among group O females. If the external environment in which the Cape Coloured population live today favours severe O-A/B haemolytic disease among them, then the conditions under which the earlier Western European settlers at the Cape raised their families may well have been responsible for a high incidence of this disorder, with consequent loss of AO heterozygote foetuses and children. Among Western European peoples, haemolytic disease due to O - A incompatibility is much more common than that due to O - B incompatibility. Since the *A* gene already had a lower frequency than *O* among Western European

immigrants, it would have decreased further in successive generations, particularly if affected families compensated by producing several group O homozygote children.

These considerations may apply to the donors with Afrikaans names, and not to those with English names, because the former were at the Cape in earlier times. Presumably hygienic conditions improved during the 150 years before the British arrived. Also, the earlier Dutch, French and German immigrants have by now had about double the number of generations of the first British families, and in general they and their descendants have had larger families. Therefore, if the loss of *A* genes results from selective forces determined by the external environment in combination with inbreeding of a local population (genetic drift). it could be expected that the donors with Afrikaans names would show a more noticeable decrease.

The question arises: Do blood group systems, other than the ABO and Rh systems, provide genes of suitable frequency for calculating Asian and Southern African X values in mixed populations of West European origin? The gene Fy^a occurs with a high frequency among South-East Asians. The Western European gene frequency is intermediate between this high frequency and the relatively low frequency of 15% in the indigenous Southern African. No other gene among those determined in this study escapes from this objection, that the frequencies in the base populations are too close together, or that a concurrent inflow from two base populations relative to a third base population, will seriously affect the equilibrium in the hybrid.

The Asians do not possess a typical gene, such as the Southern Africans possess in the Henshaw gene. The very occasional occurrence of this blood group among the White schoolchildren speaking both languages is of undoubted significance, but the sample is too small to permit statistical analysis of this observation.

Comparison of blood group gene frequencies provides a valuable and, in certain situations, an accurate anthropological tool, but it suffers from one disadvantage compared with social anthropological measures, such as language and other cultural characteristics. It cannot measure depth of time at which changes occur. A blood group survey which includes individuals of two or more genetically distinct populations may show a pattern more or less similar to that which would be observed in a recent or old hybrid population derived from them.

Evidence of stratification was not found among White blood donors. ABO frequencies of many small samples were notably homogeneous. This was not so among English-speaking children. The sample of 1 school out of 5 differed significantly from the remainder in its high proportion of apparent admixture (Table XIX). When the sample from the differing school is excluded, the remainder discloses a proportion of admixture remarkably similar to that obtained by ABO X values in White donors with British names. It is also very similar to that of the Afrikaans-speaking sample, but still differs in that the proportion based on calculations of *cDe* (7%) frequencies is larger than that indicated by *cde* frequencies (4 - 5%). All the admixture could be Southern African.

It is of interest that in this instance a higher proportion of admixture was associated with a higher percentage of 'Afrikaans' names in an English-medium school. After exclusion of this one exceptional school, the remaining sample of English-speaking children included 15% with 'Afrikaans' family names. These were 12% with 'British' names among Afrikaans-speaking children. These latter figures correspond only approximately to the 11% of donors with Afrikaans family names who attend English-Scottish churches, and 8% of donors with British names who profess the Dutch Reformed faith. The two sets of samples are not exactly comparable, being constituted of children in one instance and adults in the other. It may be that the two language sections of the White population are more conservative in interchanging their church; alternatively, it may be that in a succeeding generation cultural criteria—name, language—for separating these two sections are less useful.

Blood group data by themselves, as reported in this study, reflect no more than the present position as regards the Afrikaans-speaking population and the English-speaking Gentile population within a White community demarcated as such by membership of a blood donor society and by school attendance. The evidence of the ABO, Rh and Henshaw genes, which are inherited quite independently from one another, concur in suggesting that the Afrikaans-speaking White community of the Cape, as represented in this study by blood donors and school children, possess minor South-East Asian as well as Southern African genetic components; while the English-speaking White community may possess the latter only.

The estimate that the Afrikaans-speaking population possesses a total of 6 - 7% of blood group genes not derived from Western Europe, agrees remarkably well with the estimate of 6,8% by genealogical calculation.[5] The evidence that only the Afrikaans-speaking White population possess a detectable South-East Asian inheritance, in addition to the Southern African inheritance, the latter being common to the English-speaking population also, is in accord with the social history of these population groups.

Care is required in drawing inferences from the gene frequencies of mixed populations as regards the social behaviour of the base populations, or even of the earlier generations of the hybrid populations. Elsdon-Dew[350] has demonstrated mathematically that after a process of hybridization, for any given point of gene frequency equilibrium on the line connecting the frequencies of the participating races, there is a marked difference in the proportionate numbers of the two races which were required to achieve this point, depending on whether both sexes or only one sex of the incoming race participate. With absolutely free mating of both sexes of both races, the resultant gene frequency is the average of frequencies of the two participating populations, with a direct relationship to their proportions. When only one sex from one of the races participates, the resultant hybrid frequency is set much closer to that of the race in which both sexes participate.

According to contemporary records the early stage of hybridization at the Cape was not a simple process. Western European and South-East Asian admixture was due almost exclusively to European males, and South-East Asian - Southern African admixture due to South-East Asian males. Western European and Southern African hybridization was also 'unisexual' and a very considerable proportion of the Western European genes in that gene

pool which contained also Southern African genes, were contributed by males from the Western European - South-East Asian hybrid population. Subsequently the hybrid population bred freely within itself but continued to receive genes almost exclusively from the males of the base populations. Hybridization was a dynamic process spanning 10 - 12 generations: males and females from all the base populations (except the indigenous Southern African) continued to arrive in considerable numbers during the first 150 years; individuals already hybridized in the form of Malagasy (Southern African - Indonesian) and probably also European - Asian from the East, joined the Cape-born population. It seems as if the only non-participant in this process was the indigenous Southern African (Hottentot) male; Western European women did so to a limited extent and then mainly after several generations of hybridization had produced so-called mestizzo or light-skinned individuals.[45,53,155,156]

Populations which are transferred geographically but do not hybridize have been found to retain their characteristic pattern of blood group gene frequencies over several generations in their new environment. They continue to differ completely in their frequency pattern from the other non-mixed populations living under similar conditions in the same area. On the basis of such observations, Nijenhuis[151] has stated that the mechanism of selection which maintains a stable pattern of blood group frequency does not act through the external environment, but is in itself racial in origin. The effective environment is that internal climate created by all the genes of an individual acting together. A hybrid population possesses a new gene composition, and the concerted action of the new combination may exert new selective forces for any single gene. A blood group gene of comparatively low frequency in two base populations may, in the new genetic climate, be favoured and therefore achieve eventual equilibrium at a frequency higher than that expected by mathematical calculation. The reverse may apply. It is possible for the hybrid frequency to be beyond the range in the base populations. Such a selective force operates by inbreeding on the part of the hybrid population. When mixture occurs all at once and is a result of free 'bisexual' mating, the resulting frequency in the first or earlier generation is an average of the original frequencies. Through selection the equilibrium in the hybrid may change in succeeding generations. Therefore, calculation of the racial composition in later generations need not reflect the proportions of the mating which occurred between the base populations, even if the base populations do not continue to contribute. Glass and Li have pointed out that Bernstein's calculation assumes that all the admixture occurs at once.[149] The process of hybridization at the Cape does not comply with this assumption.

Even in a situation where the admixture did occur all at once, social selection may affect the inbreeding of the hybrid population. When the process of hybridization involves changes in evident anthropological characteristics, e.g. skin colour, hair texture, facial features, there is a general tendency for like to mate with like. Even though the genes for external appearance and the genes for blood groups are inherited independently, a mixed population of African and European descent has been shown to have either a more or a less African Rh blood group pattern according to whether the sample is selected for darker or lighter skin colour.[91]

For these reasons, among others, blood group gene frequencies of a mixed population indicate no more than the genetic composition of a particular sample. The gene frequencies of the Cape Malay may be taken as an example; the frequency pattern indicates a significant Southern African component. For the purpose of this study this population group was subdivided on the basis of professed adherence to the Moslem faith. There is recorded evidence that conversion of non-Asian slaves and free-born Coloured individuals not of pure Asiatic blood to this faith has been taking place from the early days of the settlement,[157] and conversion by intermarriage is not uncommon today. For the purpose of our study, only professing Moslems who were born in that faith were accepted. Among factory workers, a significant number of 'Malay' married women were excluded. In the schools, their children would have been included.

CONCLUSION

Blood group gene frequencies differ among population samples at the Cape, as elsewhere in the world. When likely explanations are considered as to why Cape population groups in this study differ from their races of origin in respect of their blood group genes, the logical conclusion is that genetic mixture of the people of origin has occurred, giving rise to populations with dissimilar, or new, genetic constitutions.

The gene frequencies observed among the people of the Cape are the result of a complex process of gene mixing, the gene flow being complicated by its duration, by multiple confluence and by cross-currents. The degree of admixture is therefore not suitable for exact calculation by standard methods. Nonetheless, when gene frequencies were combined arithmetically on the basis of historical information, it was possible to combine the excessive number of different population values in a manner which permitted analysis.

What are these results worth? They are expressed as percentages which represent a racial component in a mixture. From the manner of calculation in this study, the percentages cannot be accepted as arithmetically exact values. In each instance two of the three sets of population frequencies required in the mathematical equation were approximations derived by preliminary calculations. The quantitative worth of these calculations thus depends on how accurately the selected population samples represent the ethnic influence of each of 3 main geographical areas, and how correctly these samples were combined to represent the genetic influence of these areas in the Cape. This is not an easy matter to judge.

In respect of those gene frequencies which were employed in the analytical calculations, major alterations in the ratios with which the base populations were constituted do not change the calculated percentage value of the genetic component to such an extent as to invalidate the general conclusions. This is so because the gene frequen-

cies are characteristic for the whole of a geographic area and different by relatively wide margins from one area to the other.

This conclusion is best illustrated by the Southern African gene frequencies. The nature of the Southern African increment to the Cape population was the most difficult to assess historically for several reasons. Census returns do not state how many 'pure Hottentots' were at the Cape at different times. Importation of Madagascar slaves was much reduced towards the end of the 18th century and relatively many more Mozambique slaves came to the Cape during the early part of the next century under British occupation. In choosing a ratio of Hottentot: Madagascar: Mozambique gene frequencies in a total Southern African component, the importance of each of these is finally determined by their number at any given time in relation to the number of the other two, and to the size of other populations at the Cape at the same time. The earliest Malagasy arrived when there were hardly a hundred individuals in the settlement; there were already thousands of 'free blacks' in addition to thousands of slaves when the main influx from Mozambique occurred.

The *cDe* frequency of a base population consisting of any combination of these three Southern African peoples must lie in the range 43,08 - 76%. Taking the frequency at the two extremes, the calculated Southern African component in the non-Malay Coloured is 41 - 74,7%; and in the sample of English-speaking schoolchildren who remain after exclusion of an exceptional school, this component is 5,4 - 9,8%. Although there is a large arithmetical difference, the main conclusions are not altered. For this reason we feel that some uncertainty as regards the proportions of the different people constituting the base populations does not present too serious an objection to the conclusions.

The qualitative value of the results of the blood group gene frequency calculations is proved by other observations. The presence of a Southern African genetic component in these four population groups at the Cape is established beyond real doubt by the occasional occurrence of the Henshaw blood group and the African form of glucose-6-phosphate dehydrogenase deficiency in all; the rare occurrence of haemoglobin E in the Afrikaans-speaking population (among others) indicates an Asian heritage, while occasional instances of haemoglobin C (which presumably arrived from West Africa mainly before 1660) in the rural Afrikaans-speaking population of the Cape, Free State and Transvaal provides indirect confirmation of the time when genes were exchanged.

We cannot put forward additional evidence to confirm the quantitative value of our calculated percentage admixture. However, no reasonable choice of population samples to represent regional genetic characteristics, nor the manner of combining these to represent the total gene influx will affect the essential conclusion: that gene mixing at the Cape was responsible for new gene frequency patterns; and this resulted in both sections of the Cape Coloured population of today possessing major European, Asian and Southern African genetic components, but in significantly different proportions, while the two major sections of the White population possess a minor Southern African genetic component and the Afrikaans-speaking sample probably a minor Indian - South-East Asian component as well.

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